Linking Asia's Trade, Logistics, and Infrastructure

Douglas H. Brooks

December 2008

ADB Institute Working Paper No. 128

Douglas H. Brooks is a senior research fellow at the Asian Development Bank Institute (ADBI).

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Suggested citation:

Brooks, D. H. 2008. Linking Asia's Trade, Logistics, and Infrastructure. ADBI Working Paper 128. Tokyo: Asian Development Bank Institute. Available: http://www.adbi.org/working-paper/2008/12/31/2796.linking.asia.trade.logistics.infrastructure/

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

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Abstract

Infrastructure services, from both hard and soft infrastructure, play a vital role in facilitating Asia's export-led growth by keeping the prices of delivered goods in export markets competitive. Efficient infrastructure services lower transaction costs, raise value added, and increase potential profitability while also increasing and expanding linkages to global supply chains and distribution networks for producers. Asia's trade patterns are characterized by a high degree of intraregional trade, particularly in parts and components for geographically fragmented production networks. This is both in response to, and with implications for, further infrastructure development. Logistics services play a key role and the challenges of providing efficient logistical support rise as countries move into progressively more complex and higher-value manufacturing, and as production processes become increasingly fragmented.

JEL Classification: F15, F13, O19

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I. INTRODUCTION

The reemergence of Asia as an economic powerhouse in recent decades owes much to the expansion of its international trade. International trade even played a critical role in the region's recovery from the 1997–1998 financial crisis. Asia's trade expansion has in turn been facilitated and encouraged by the development of supporting infrastructure, including both physical (hard) and institutional (soft) infrastructure, and logistics services. From 1975 to 1995, developing Asia's port capacity increased from 3 million to 62 million TEU,[1] an average annual growth of over 15%. Airfreight shipments in the region increased roughly 14% annually during the same period, from less than 2 billion to more than 30 billion ton-kilometers. Investment in infrastructure has been complemented in turn, and spurred, by foreign and domestic investment in productive capacity as well as by structural reforms that improve the environment for investment, production, and trade.

Infrastructure services can reduce distribution margins, narrowing the gap between prices faced by producers and consumers, thereby facilitating welfare improvements for both. On the supply side, the expansion or improvement in quality of infrastructure services can lower marginal costs, raising the minimum efficient scale of production, transportation, or marketing. These lower costs and greater economies of scale raise the potential for initial or increased sales to export markets, as well as domestic sales. Indeed, a significant part of infrastructure's contribution to growth and poverty reduction in Asia comes through its facilitation of international trade expansion. It expands both the scope for domestic absorption and supply to export markets, while stimulating linkages with and between different sectors and industries, and providing incentives for innovation.

Asia is benefiting from market-driven integration, where large trade and foreign investment flows respond to infrastructure development, outward-oriented policies, and incorporation into international production networks and regional cooperation frameworks. Both Asian and non-Asian multinational corporations have developed international supply chains linking different parts of the region and openness to foreign direct investment (FDI) has become the norm. Financial integration has supported these developments by increasing access to credit and innovative financial instruments. Tariffs and quotas have been reduced through successive rounds of multilateral negotiations under the General Agreement on Tariffs and Trade (succeeded by the World Trade Organization [WTO]) and the recent plethora of bilateral and regional trade agreements. But infrastructure in many Asian countries is still inefficient, if not inadequate. Inability to transport goods and people efficiently or an inadequate power supply to operate machinery smoothly leads to microeconomic as well as macroeconomic imbalances. In this economic environment, infrastructure-induced reductions in trade costs have become relatively more important than direct policy barriers as sources of further cost savings (Brooks, Roland-Holst, and Zhai 2005).

Efficient infrastructure services lower transaction costs, raise value added, and increase potential profitability while increasing and expanding linkages to global supply chains and distribution networks for producers, and a country that is more deeply involved in global production networks will likely benefit more from trade-related infrastructure investment than one that is not. In a study incorporating threshold effects, Francois and Manchin (2006) found that infrastructure is a key determinant not only of export levels, but also of the likelihood of exporting at all. Investments in expanding and upgrading transport and telecommunications infrastructure figure prominently in this regard.

While trade and logistics infrastructure often evokes images of large-scale physical projects, soft (or institutional) infrastructure is equally important. A supporting environment of predictable legal and judicial rights and procedures, equitable and enforceable competition policy, and a sound but not unduly restrictive regulatory framework are crucial for physical infrastructure investment to be efficient. Financial services, including financial intermediation,

[1] TEU is a standard measure of shipping volume and represents a twenty-foot equivalent unit.

risk management opportunities, and payment and clearing services are especially important for facilitating international trade. Bond markets capable of supplying long term finance in local currencies ideally play a central role in infrastructure finance, but are still in an early stage of development in most of Asia.

Cooperative efforts to broaden, deepen, and strengthen these markets throughout the region in support of greater trade are expanding dramatically. The international externalities that arise as infrastructure services support cross-border trade flows indicate an important role for regional cooperation to incorporate and maximize social benefits (Maur 2008). Regional cooperation in trade and logistics strengthens regional economic growth and integration, allowing greater regional investment in cross-border infrastructure projects. This can perpetuate a virtuous cycle.

II. RECENT TRENDS IN ASIA'S AGGREGATE TRADE[2]

Exports from developing Asia and the Pacific accounted for about 24% of the world total in 2005. East Asia alone accounted for more than 16% of world exports. Consequently, much of the dynamism of Asia's trade, and the impacts of infrastructure development and regional cooperation, can be seen by focusing on East Asia,[3] a dynamic region in terms of trade and economic growth. This region's economies have continued to become more exposed to international trade over the last decade, with merchandise exports increasing from 34% of gross domestic product (GDP) in 1995 to 42% in 2005, even while GDP was growing rapidly.

Table 1 presents the export value of East Asia and major comparator country groups for selected years over 1990 to 2005, along with their market shares in global trade. The People's Republic of China (PRC) is included both with the rest of East Asia and as a comparator since it has been playing a particularly prominent role.

East Asian exports accounted for over one fifth of the world's total exports in 2005. The growth in world market share of East Asian exports (from 13.0% in 1990 to 21.7% in 2005) came mostly from East Asian intraregional trade (from 4.2% in 1990 to 9.1% in 2005 as shares of world exports) and from the trade between PRC and the other East Asian economies (from 0.8% in 1990 to 2.9% in 2005 as shares of world exports). It was far greater than that for any of the comparator groups. The export value of East Asian intraregional trade grew by 13.4% from 1990 to 2005, while East Asia's exports to PRC grew faster, by 17.8% in the same period. In contrast, the world market share of North American Trade Free Agreement's (NAFTA) exports rose by no more than three percentage points from 1990 to 2000 and declined more than four percentage points from 2000 to 2005. The relative importance of the European Union (EU) (15) was declining from 1990 to 2000 before slightly increasing from 2000 to 2005.

The table shows that PRC is playing a more and more important role in world trade and in East Asia trade. The share of PRC's exports in East Asia rose from less than 15% in 1990 to over 35% in 2005. The reemergence of PRC as an international trading power has had a major impact on the other economies of Asia, both as a competitor in world markets and as a dynamic and growing market for the other Asian economies.

[2] Jinkang Zhang contributed substantially to this section.

[3] East Asia in this section refers to: Brunei Darussalam; Cambodia; PRC; Hong Kong, China; Indonesia; Republic of Korea; Lao People's Democratic Republic; Malaysia; Mongolia; Myanmar; Philippines; Singapore; Taipei,China; Thailand; Viet Nam. Note that it does not include Japan.

Table 1: East Asia and Other Selected Regions/Countries in World Trade

Group	Total Exports (US$ billion)				Share of World Trade (%)			
	1990	1995	2000	2005	1990	1995	2000	2005
East Asia (15)	417.8	870.4	1,193.9	2,136.6	13.0	17.9	19.2	21.7
Central and West Asia (8)	-	5.6	14.9	34.7	-	0.1	0.2	0.4
South Asia (8)	27.2	43.7	60.7	125.8	0.8	0.9	1.0	1.3
ASEAN (10)	141.3	311.3	420.9	607.6	4.4	6.4	6.8	6.2
NIEs (4)	267.1	528.5	661.1	995.6	8.3	10.9	10.6	10.1
PRC	62.1	148.8	249.2	762.0	1.9	3.1	4.0	7.7
European Union (15)	1,476.8	2,010.3	2,196.2	3,585.5	45.8	41.4	35.2	36.4
NAFTA (3)	546.1	853.6	1,223.6	1,478.7	16.9	17.6	19.6	15.0
United States	392.9	583.0	780.3	904.3	12.2	12.0	12.5	9.2
Japan	286.9	442.9	479.2	594.9	8.9	9.1	7.7	6.0
Latin America and the Caribbean (LAC)	121.6	221.2	347.5	549.4	3.8	4.6	5.6	5.6
Middle East (MNA)	91.5	87.5	169.9	311.5	2.8	1.8	2.7	3.2
Sub-Saharan Africa (SSA)	11.9	46.8	85.9	82.3	0.4	1.0	1.4	0.8
MERCOSUR (4)	46.4	70.5	84.8	161.3	1.4	1.5	1.4	1.6
MEMO ITEM								
East Asian Intra-regional Trade	136.1	344.7	456.4	901.7	4.2	7.1	7.3	9.1
East Asia Extra-regional Trade	281.7	525.7	737.4	1,234.8	8.7	10.8	11.8	12.5
East Asia to Europe Union (15)	65.1	120.7	176.1	308.2	2.0	2.5	2.8	3.1
East Asia to United States	94.2	172.9	252.1	365.9	2.9	3.6	4.0	3.7
East Asia to Japan	61.7	112.3	145.9	203.8	1.9	2.3	2.3	2.1
East Asia to PRC	24.3	75.7	109.0	282.7	0.8	1.6	1.7	2.9
Europe Union (15) Intra-regional Trade	972.6	1,247.5	1,342.7	2,140.8	30.2	25.7	21.5	21.7
NAFTA (3) Intra-regional Trade	225.8	392.9	681.6	824.4	7.0	8.1	10.9	8.4
ASEAN (10) Intra-regional Trade	26.8	77.4	96.7	155.6	0.8	1.6	1.6	1.6
MERCOSUR (4) Intra-regional Trade	4.1	14.5	17.7	21.1	0.1	0.3	0.3	0.2
WORLD EXPORTS	**3224.8**	**4853.9**	**6233.1**	**9859.0**	**100**	**100**	**100**	**100**

Notes: 1. Emerging East Asia (15): Brunei; Cambodia; PRC; Hong Kong, China; Indonesia; Republic of Korea; Lao PDR; Malaysia; Mongolia; Myanmar; Philippines; Singapore; Taipei,China; Thailand; Viet Nam

2. Central and West Asia (8): Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan.

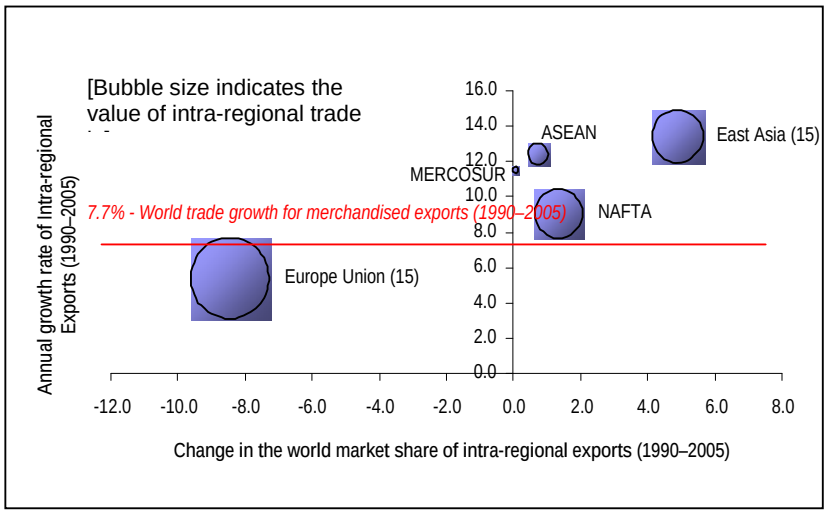
3. South Asia (8): Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.

Source: Calculated from UN Comtrade data (S2, items-total).

East Asia's intraregional trade, which accounted for 42.2% of the region's exports in 2005, increased marginally more rapidly than its extra-regional trade. The annual growth rate of East Asian intraregional trade from 1990 to 2005 was 13.4% versus 10.4% for its extra-regional trade, and exceeded the growth of intraregional trade for NAFTA (9.0%), EU (15) (5.4%), and Mercado Comun del Sur (MERCOSUR) (11.5%).

Figure 1 shows world market share changes for five major regions' exports. The figure also shows the value of intraregional trade in 2005, and annual growth rates for the period 1990 to 2005, with the world growth rate shown for comparison. The dollar value of intraregional trade in East Asia is now slightly larger than that in NAFTA, and although both regions experienced increases in world market shares over 1990 to 2005, growth was faster in East Asia.

Figure 1: Intra-regional Trade of Major Regions, 1990–2005



Source: UN Comtrade data.

Roughly a quarter of world trade occurs between countries sharing a common border. Half of world trade takes place between partners less than 3,000 kilometers apart (Berthelon and Freund 2004). Even so, for Asia only 1–5% of trade by value is with land-neighboring countries. For trade with non-adjacent partners, nearly all merchandise trade moves via ocean and air transport modes. The 10-fold decline in air shipping prices since the late 1950s means that the cost of speed has fallen dramatically. Since the marginal cost of air shipping cargo per additional mile is falling rapidly, over time the average air shipment is traversing a greater distance and the average ocean shipment is getting shorter (Hummels 2007).

III. INFRASTRUCTURE AND TRADE COSTS

The quantity of infrastructure investment, the quality of infrastructure services, and logistics coordination of those services, influence trade performance (see e.g., Limao and Venables 2001; Clark, Dollar, and Micco 2004). This occurs through impacts on pecuniary transaction costs, loss, damage and spoilage to goods in transit, and timeliness of delivery, among other factors.

Nordas and Piermartini (2004) highlight four central aspects of the relationship between infrastructure and trade transaction costs:

1. *Direct monetary outlays* on communications, business travel, freight, insurance, and logistics services are affected by the quality of infrastructure and the cost and quality of related services.
2. *Timeliness*, even more than freight rates, is likely to be influenced by geography and infrastructure.
3. *Risk* of damaged cargo and resulting increased losses and insurance costs is higher when infrastructure quality is poor.

4. *Lack of access* to transport or telecommunication services can have a high opportunity cost, limiting market access and reducing the likelihood of realizing the full benefits of trade.

The relative weights of different categories of trade costs that reflect different infrastructure services can be surprising. As De (forthcoming 2009a) notes, in 2005 the ocean freight rate for importing a container to India was about two thirds *greater* than for exporting. At the same time, ocean freight for importing a container to PRC from six Asian countries was far *lower* than for exporting. Auxiliary shipping charges (documentation fees, container handling charges, government taxes and levies, etc.) may account for much of this difference and are sometimes greater than the ocean freight charges, particularly where shipments experience congestion at ports or borders. On average, auxiliary shipping charges outweigh terminal handling charges across countries and commodities in Asia, with variation in such charges contributing significantly to variations in trade costs. Improvement in logistics services, including cross-country coordination, may help to lower both the average cost and the variability. This highlights one area of potential for regional cooperation in strengthening soft infrastructure to contribute to lowering trade costs.

The composition of freight charges also varies significantly across countries and commodity categories. De finds that the share of total freight charges accounted for by inland freight is sometimes less than that of ocean freight, but is frequently greater. The actual balance depends on the country, suggesting an inland focus for trade-related infrastructure priorities in those countries where the inland share is greater. A 10% reduction in transport costs (expressed as an ad valorem tax equivalent) would boost Asia's trade by about 3–4% from what it would otherwise be. When trade is differentiated by commodity groups, the weight to value ratio is found to be the major determinant of transport cost, suggesting that road, rail, and sea may be the increasing order of modal preference for transporting heavier cargos.

Hummels and Skiba (2004) similarly found that a 10% increase in the ratio of product weight to value results in a 4% increase in ad valorem shipping costs. Hummels (2007) notes that from 1960–2004, the real value of trade in manufactures grew about 1.5% per year faster than the weight of non-bulk cargoes. If bulk commodities are included in the calculation, the real value of all trade grew 1.8% faster per year than the weight of all trade.

Note that an important component of transportation costs is the time cost involved. This is particularly critical for perishable or other time-sensitive goods. Hummels (2001) found that the time cost of one day in transit for US imports is equivalent to an ad valorem tariff rate of 0.8%, implying the equivalent of a 16% tariff on an average trans-Pacific shipment of 20 days. Clearly, improvements in infrastructure services that reduce delays in border crossing procedures, transit times, or ports will influence a country's propensity to trade. Costs related to the time elapsed between the perception of demand and subsequent supply of products to the relevant retailer(s) can also figure prominently (Nordas and Piermartini 2004). Developments in containerization and multimodal transport networks with corresponding logistics support are contributing to quicker delivery times and the growth in air shipments.

When growth is very rapid, congestion results as the increase in traffic induced by the economic growth outpaces the expansion of transportation infrastructure services. Ma and Zhang (forthcoming 2009) find this to be the current situation in PRC. Sea port congestion there results from the long neglect of access transport and port facilities infrastructure. Six percent of the world's rail lines struggle to move one-fourth of the world's rail freight turnover, and only 2% of the country's highway network is expressways.

Congestion has been rising most notably at the port of Shanghai, as inefficiencies from overloading the physical infrastructure are compounded by a lack of collaboration among different stakeholders. In terms of soft infrastructure, reliability of trade facilitation and administrative procedures at customs are crucial, including rationalization of the customs transit system in order to reduce inspection time and simplify declarations and the documentation process. Meanwhile, Shanghai's congestion is reducing its competitiveness

relative to nearby ports in neighboring economies, endangering its status as a hub and gateway to international markets and suppliers. In recent years, the number of transshipped containers from Shanghai via Hong Kong, China have accounted for as much as 20% of the total container throughput of Shanghai.

Limited infrastructure connections to western regions in PRC result in high trade costs for inland regions and impede regionally balanced growth. As land and labor costs rise near coasts, investors look to locate production facilities farther inland. However, they are hampered by insufficient or poor quality infrastructure connections that raise transportation costs to and from those areas. This has led to a shift in infrastructure policy emphasis to give greater weight to hinterland access. Railway construction is crucial for inland provinces, where a greater share of production is of bulk commodities. At the same time, the lack of a seamless logistics management system adds to delays in use of multimodal transportation systems in inland areas, where they may be most valuable.

Infrastructure inland from the border can have as much effect on the length and variability of time-to-market as freight services between countries. This is especially true in large or landlocked countries, and the proliferation of inland dry ports has evolved partly in response. Limao and Venables (2001) found that domestic infrastructure explains about 40% of transport costs for coastal countries, while domestic and transit country infrastructure together account for an estimated 60% of transport costs for landlocked countries. Furthermore, land transport is about seven times more costly than sea transport over similar distances, and estimates of the elasticity of trade flows with respect to transport costs range from -2 to -3.5, suggesting that lowering a landlocked country's trade costs by 10% through regional cooperation for infrastructure development could increase its exports by over 20%.

De (forthcoming 2009b) finds that inland transport cost is the major component of overall trade transportation costs in South Asia, accounting for about 88% of the total. Inland costs are very high across South Asian countries, except in Sri Lanka, and vary across goods and countries, being even higher when countries are landlocked. Land border crossings are overcrowded, and greater policy attention to efficiency concerns could easily reduce delays and monetary costs. Complex border-crossing requirements expand possibilities for corruption and have encouraged sharp growth in informal trade. The border effects in South Asia and its low share of intraregional trade argue strongly for cooperative improvements in soft infrastructure complemented by inland transportation infrastructure, to raise exporters' competitiveness.

IV. EMPIRICAL ESTIMATES OF TRADE COSTS

Empirical assessments of trade costs are most frequently derived through estimation of a gravity equation. An excellent survey of trade cost estimation can be found in Anderson and van Wincoop (2004). They estimated that the tax equivalent of representative international trade costs is about 74% for industrialized countries, including 21% transportation costs and 44% border-related costs.[4] Costs for developing countries can be much higher.

De (2008) estimates a modified gravity equation for eight sectors in 10 Asian countries, controlling for distance, to examine the effects of both policy and non-policy barriers to trade. In this framework, infrastructure quality and transport costs, along with tariffs, are found to be the main determinants of cross-country variations in trade flows. Infrastructure interventions that reduce the costs of international trade are therefore crucial for the region to fully realize the gains from recent and prospective trade policy liberalization.

There is often skepticism as to the extent to which the benefits of trade-related infrastructure in developing countries accrue to the poor. Lao People's Democratic Republic (Lao PDR) is a poor, landlocked, rugged, mountainous country with generally low quality roads. The

[4] The costs are not simply additive. The total is 1.44*1.21-1=0.74.

poorest people often reside far from urban centers and are the most disadvantaged by the high transport costs resulting from bad roads. Inadequate or substandard roads present an obstacle to realizing the potential benefits for rural residents from recent economic reforms and international trade. Menon and Warr (2008) use a general equilibrium modeling approach to assess the impact of rural road improvements on the incidence of poverty. They differentiate rural villages into three categories based on the quality of road access available: (i) no vehicular access, (ii) dry season only access, and (iii) all weather access. Although road improvement in all three categories reduces poverty, the type of road improvement determines the magnitude of the impact. When areas with no vehicle access are provided with dry season access roads, the reduction in poverty incidence is about 17 times that which occurs when roads suitable only for dry season access are upgraded to all weather access roads, and the effect on GDP is about six times as great. Thus, enabling transport of traded goods for households without initial road access is highly pro-poor compared to road improvement for households already having dry season road access to markets.

The way in which road infrastructure, whether domestic or cross border, affects trade operates mainly through reductions in transport costs, which also underlie the poverty impact. Furthermore, reductions in transport costs have an indirect positive impact on FDI inflows by reducing transaction costs in intra-firm vertical integration that is designed to exploit countries' comparative cost advantages. Increases in FDI, in turn, can further increase regional trade, and add to the direct effect of reduced transport costs achieved through improvements in road infrastructure near border areas. When such gains are present, this reduces tendencies towards production agglomeration. If the advantages of production integration across economies outweigh those from agglomeration, then reductions in transport costs make FDI complementary to trade. This defines a virtuous cycle of cross-border infrastructure development, trade, and investment that fosters increased trade and economic growth.

Edmonds and Fujimura (2008) investigate the impacts of infrastructure development on trade and FDI, focusing on both domestic and cross-border infrastructure in the Greater Mekong Subregion (GMS). They estimate gravity models using panel data from 1981 to 2003 for trade and FDI flows between each pair of the six GMS countries. The results show that the quality of road infrastructure in border areas between economies has a positive and statistically significant relationship with trade flows between them, and that this relationship is particularly strong when both cross-border and general domestic road infrastructure are included in the estimates. They also find that cross-border roads have distinct effects from domestic road infrastructure, suggesting that investments in cross-border infrastructure have an independent and important role to play in the promotion of regional trade and may therefore justify cooperative development of this infrastructure.

Cross-border road infrastructure was estimated to have a positive but not statistically significant association with FDI. The weak relationship could be due to data shortcomings, since the number of countries reporting FDI flows at disaggregated levels is limited. Despite these data limitations, there is some evidence of a positive trade-FDI nexus in which FDI contributes to export growth from FDI-recipient economies.

V. TRADE FACILITATION

Reductions in trade costs resulting from infrastructure improvements or expansion are one form of trade facilitation, but trade facilitation can be defined in many ways. In the context of the WTO, it primarily refers to simplifying or speeding up administrative documentation procedures at border crossings. In broader usage, it includes measures taken by both public and private sectors, reduction in nontariff barriers, and improvements in physical facilities to smooth the movement of shipments by reducing time in transit. Thus, it may encompass both hard and soft infrastructure that facilitates trade.

Dee, Findlay and Pomfret (2008) include all factors affecting time and money costs of moving goods across international borders in the scope of trade facilitation. The success of reforms to facilitate trade depends on their impact on both rent-creating and cost-creating influences. Use of price-cost margins to measure performance helps identify rent-creating barriers, while use of cost or productivity as performance measures can identify cost-creating barriers. The identification is important in designing policy responses since the treatment effect (as rent-raising or cost-raising) can dominate other factors in the estimated height of trade barriers. They use antimonde estimation, in which a measure of economic performance is estimated for the counterfactual case with no nontariff barriers in a market to quantify the extent to which nontariff barriers lead to vertical shifts in demand or supply curves with consequent effects on costs and prices.

Among different indicators of infrastructure services' contributions to trade, port efficiency has the largest influence, reflecting the fact that the vast bulk of trade (by weight) is transported by sea. Infrastructure improvements that raise port efficiency from the 25th to the 75th percentile can reduce shipping costs by more than 10% (Clark et al. 2004). The dominance of sea freight over land transport and the associated cost savings emphasize the importance of transit arrangements for landlocked countries attempting to compete in global markets, as well as the importance of improving port efficiency in countries with amenable coastal areas.

Increasing port efficiency complements technological changes in shipping that yield economies of scale. Larger, faster ships and containerization reduce average shipment time at sea and in ports. Estimates by Hummels (2007) show that increasing the share of trade that is containerized by 1% lowers shipping costs from 3–13%. In addition, trade growth along a particular shipping route promotes entry, with new competition driving down transportation markups. In 2006 one out of six importer-exporter pairs was served by a single liner service; over half were served by three or fewer (Hummels et al. 2007). Service also becomes more frequent, facilitating timely delivery, and a densely traded route allows for effective use of hub and spoke arrangements, in which small container vessels feed shipments into a hub where containers are aggregated into much larger and faster containerships for longer hauls.

Haveman et al. (forthcoming 2009) show for a subsample of Asian ports that specific infrastructure investments are highly correlated with reductions in port costs. While Penang (Malaysia) currently has the lowest costs of ports studied, Mumbai experienced the greatest improvement in relative costs between 1997 and 2005. Operating with a new harbor, wharf, or terminal is estimated to decrease port costs by 2% while procurement of a new crane decreases port costs 1%. Increasing the number of berths at ports or deepening channels have less effect.

Not only do investments in port infrastructure, and especially the procurement of new cranes, lower costs and raise efficiency for current trade flows, they can also increase port capacity to handle new flows and influence the composition of trade. Port costs vary significantly across products even at a single port, and new infrastructure can, for example, differentially influence the costs for loading/unloading containers versus bulk commodities. Standardized containers yield cost savings by allowing goods to be packed once and moved over long distances via a combination of transport modes—truck, rail, ocean liner, rail, then truck again—without being unpacked and repacked. Given the inherent advantages in containerization for certain product categories, relevant port infrastructure developments can reduce unit costs further as the container share of trade rises.

Changes in the composition of trade, mode of product packing (container or bulk, for example), and the capacity expansion effect of new port infrastructure all influence the potential profitability, and hence bankability, of port infrastructure investments. In planning port expansion or improvement projects, both the efficiency and capacity effects need to be accounted for in projecting potential benefits. This is true for sea-, dry-, and airports.

Information and communication technology (ICT) is an increasingly productive complement to physical transportation infrastructure. The quality of communication infrastructure services is not only strongly correlated with search costs, but also with costs of entering into contracts with suppliers, monitoring implementation of those contracts, and monitoring the location and status of shipments.

Fink, Matoo, and Neagu (2002) find that the cost of making a telephone call has a significant and negative effect on bilateral trade flows. In addition, the costs of telecommunications have a greater effect on trade of differentiated products than on trade of homogeneous products, highlighting the value of ICT infrastructure at the dynamic extensive margin of trade. In particular, as the number of smaller shipments of a wider variety of higher value added products rises, the demand for ICT infrastructure services rises.

The same is true as growth in trade of services outpaces merchandise trade growth. Infrastructure, especially telecommunications infrastructure, is particularly important for trade in services, where the main services traded (banking and business services, communications, etc.) are highly dependent on well-developed infrastructure in both the exporting and importing countries (Nicoletti, Golub, Hajkova, Mirza, and Yoo 2003). Given the huge value of ICT infrastructure demanded, it is fortunate that ICT is an infrastructure sector which the private sector is especially adept at innovating, expanding, and financing, while the need for mutually interfacing logistics services at both ends of the trade route points to an area for regional cooperation to capitalize on informational externalities in enhancing trade.

VI. OVERVIEW OF ASIA'S INFRASTRUCTURE

Given the importance of transportation, energy, and ICT infrastructure in Asia's trade and regional cooperation, this section briefly reviews the status of these infrastructure areas.

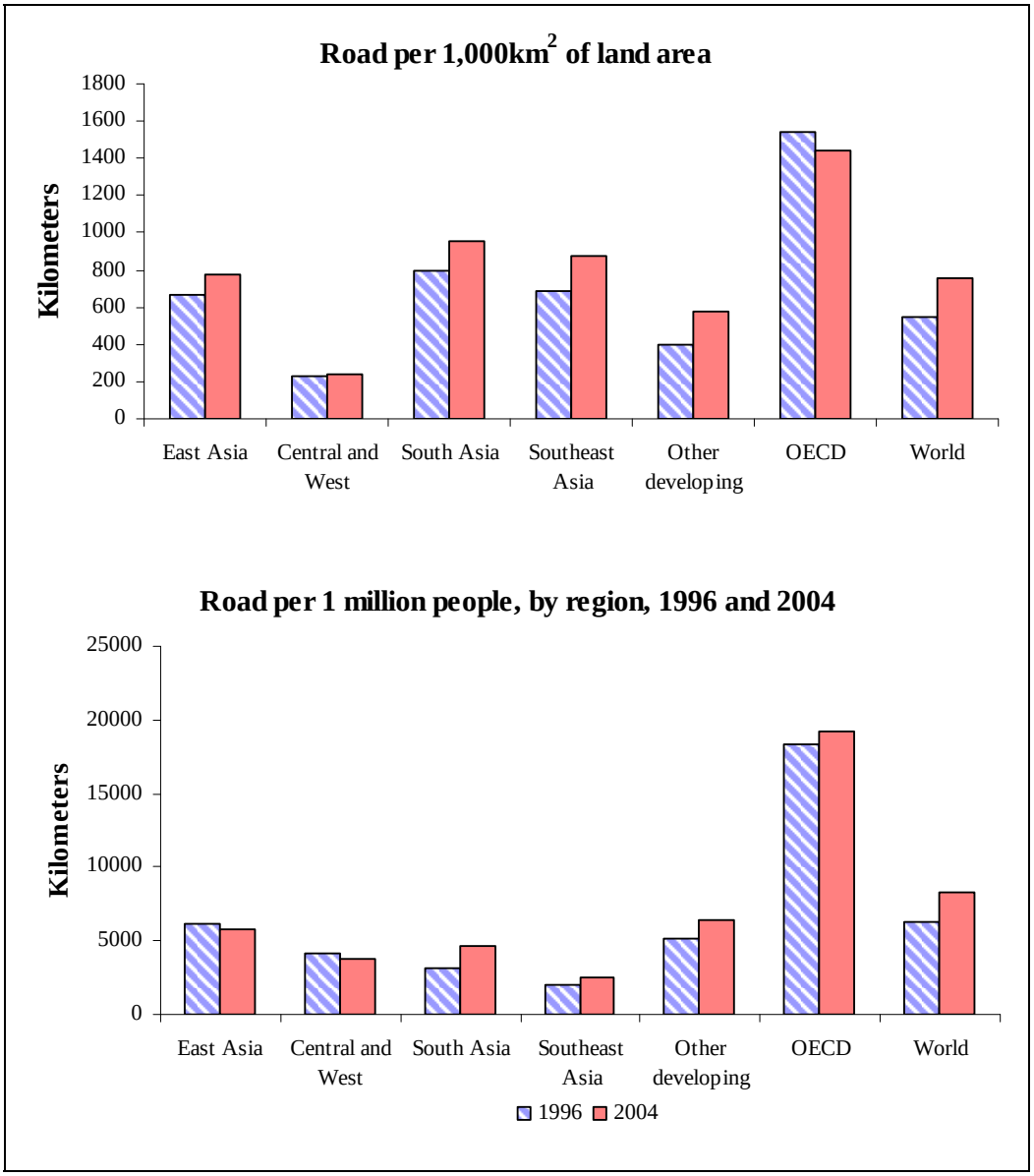
A. Transport Infrastructure

Transport infrastructure development varies across countries in the region. Some countries show a progressive pattern while others suffer a declining trend. In 2004, developing Asia's total road network covered 7.4 million kilometers, of which 65.3% was paved (Appendix Table A.1).[5] While East and Southeast Asia have improved the coverage of paved roads, Central and West Asia, which had the highest proportion of paved roads to total road network in 1996, experienced a decline. From 1996 to 2004, Azerbaijan and Georgia suffered a steep decline in coverage of paved roads, from 93.9% to 49.4% and from 93.5% to 39.4%, respectively (Appendix Table A.2), mainly due to poor maintenance and insufficient budget for upgrading existing road networks. As of 2005, approximately 50–70% of road networks in Azerbaijan and Georgia were in poor condition and required rehabilitation (Ziyadov 2008; World Bank 2008). On the other hand, East and Southeast Asian economies such as Singapore and Hong Kong, China improved the coverage of paved roads to 100%. Several countries with a low proportion of initial paved roads did not show any improvement.

Although East and Southeast Asia are increasing their coverage of paved roads, the quality of road network is still much lower than in Organisation for Economic Co-operation and Development (OECD) countries. Figure 2 shows that Asia has significantly lower road length per one million people (perhaps reflecting higher population density in Asia) road density per 1,000km^2 of land than the OECD average.

[5] This excludes the Pacific due to lack of data.

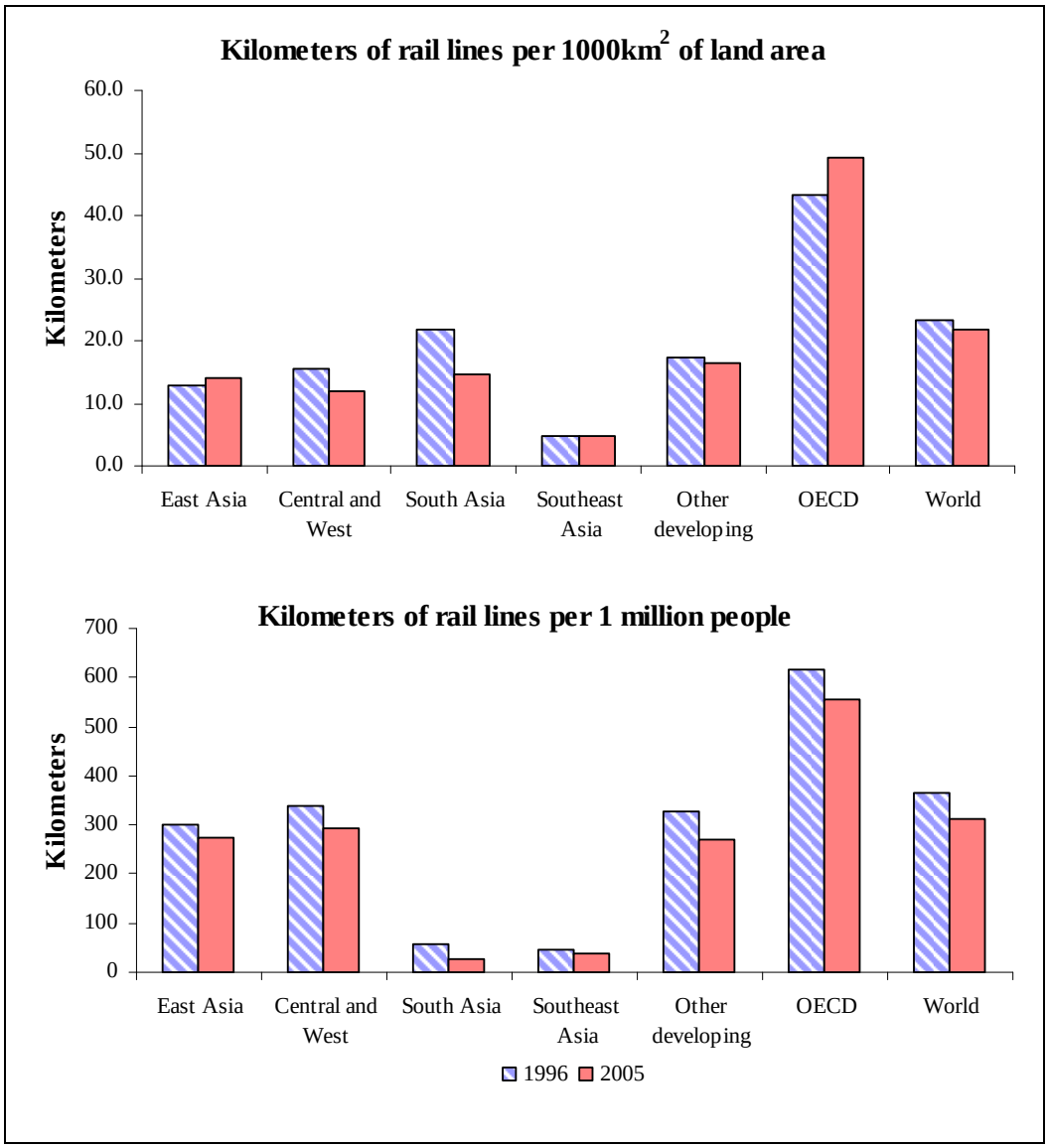
Figure 2: Road Network Indicators, by Region, 1996 and 2004



Source: World Development Indicators 2007

The region's rail network totaled 182 thousand kilometers, or around two fifths of the OECD's 472 thousand kilometers in 2005 (Appendix Table A.3). The gap is even bigger when comparing rail lines per person and per land area (Figure 3).

Figure 3: Railway Indicators, by Region, 1996 and 2005



Source: World Development Indicators 2007

Rail lines per 1000km^2 of land area fell during 1996–2005 in Asia, except for East Asia. This indicates that limited new rail routes were created while existing routes were not maintained. Armenia, Georgia, Pakistan and Viet Nam experienced declines in kilometers of rail routes. Common reasons for the poor maintenance are insufficient budget, lack of awareness of the full potential benefits of railways, and inadequate management of railway authorities.

The volume of goods transported by railway increased dramatically worldwide during 1996–2005, with Asia recording an increase of about 50% (Appendix Table A.3). Among subregions, Central and West Asian rail transport grew the highest at 85%. Data by individual country shows a varying trend (Appendix Table A.5). Hong Kong, China's goods transported by rail decreased by more than four times while Mongolia and Azerbaijan increased rail freight by about four times. Hong Kong, China's fall in the volume of rail freight may reflect less concentrated flows of bulk raw materials or fewer long-distance routes which give rise to heavy rail freight flows, and good infrastructure for other modes of transportation for its international trade. Conversely, railways are the main transportation mode for trade in

heavy bulk commodities from landlocked countries like Mongolia, where an increase in the volume of rail freight mainly reflects an increase in the volume of trade.

Air transport increased faster in Asia than in the rest of the world during 1996–2005. Goods and passengers carried by air doubled in the region, with the highest increase (about three-fold) taking place in East Asia (Appendix Table A.4). Central and West Asia and the Pacific lag behind the other subregions in terms of airport infrastructure, as shown in the individual country data provided in Table A.6. Several countries in Central and West Asia and the Pacific such as Armenia, Azerbaijan, Marshall Islands, and Solomon Islands had low and declining air transport.

Sea transport, by which most merchandise moves internationally, also increased dramatically in the region in recent years (Appendix Table A.7). The world's largest three shipbuilding countries are Republic of Korea (1); Japan (2) and PRC (3), accounting for approximately 86% of the world total (United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) 2005). Appendix Table A.7 illustrates the increasing trend in sea transportation across countries.

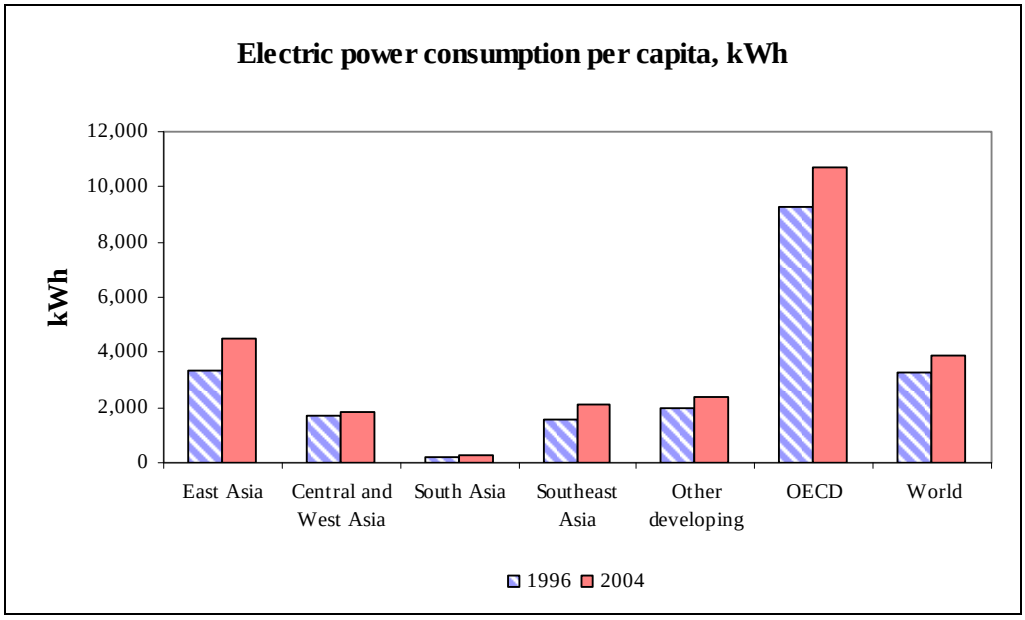
In general, transport infrastructure has been improving in the region over the last few decades. However, transportation of people and goods across different types of transport modes is not evenly developed in many Asian and Pacific countries (UNESCAP 2006). Countries with maritime coastlines are more oriented towards their major seaports and internal land transport systems are not always properly linked, due to a lack of comprehensive policies joining different transportation modes and logistics networks.

B. Energy Infrastructure

In 2004, the region (excluding Pacific due to lack of data) produced 4,057 billion kWh of electric power and consumed 3,630 billion kWh of electricity (Appendix Table A.8). Although both electricity production and consumption almost doubled the levels of 1996, Asia still remains below OECD levels. Figure 4 illustrates the level of per capita electricity consumption by region.

For individual countries, Appendix Tables A.9 and A.10 demonstrate a wide diversity of electricity production and consumption balances in the region. Economies such as Hong Kong, China; Republic of Korea; and Singapore have electricity consumption per capita of more than 5000 kWh while Pakistan, Bangladesh, India, Nepal, Sri Lanka, Indonesia, and Myanmar experience less than 500 kWh of electricity consumption per capita. In terms of electric power production, PRC alone generates more than half the region's total electricity.

Figure 4: Electric Power Consumption Per Capita, KWh



Source: World Development Indicators 2007

In 2004, the region produced 24% of the world's electricity, up by seven percentage points from the 1996 level (Appendix Table A.10). However, by subregion only East Asia accounted for a notable increase in electric power production, while other regions showed a minor increase or no change in their world shares.

In terms of energy resources, the region has considerable fossil fuel resources, accounting for 7%, 12%, and 32% of global oil, natural gas, and coal reserves, respectively, in 2006 (Table 2). However, some countries are net exporters while others are net importers. Central and West Asia has substantial oil and natural gas reserves whereas East and South Asian countries are endowed with rich reserves in coal. The largest reserves are concentrated in a few countries, with PRC, Kazakhstan, and India together accounting for 98% of the total coal reserves in the region in 2006 and Kazakhstan alone having almost the half the region's oil reserves (Appendix Table A.15).

Table 2: Proven Energy Reserves, by percentage, 2006

Region	Oil	Gas	Coal
Developing Asia	7	12	32
East Asia	1	1	13
Central and West	4	6	5
The Pacific	..	0	..
South Asia	0	1	13
Southeast Asia	1	4	1
Other developing	87	80	32
OECD	6	9	37
World	100	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 48 countries.

Source: World Resources Institute, Energy and Resources Database 2008.

Despite its energy resources, developing Asia is a net importer of energy, accounting for about 23% of world energy production and 25% of world energy consumption in 2001 (Table

3). Most of the energy production and consumption occurred in East Asia and to a lesser extent in South Asia, due to high demand for energy in the larger emerging economies such as PRC and India. Asia's energy infrastructure therefore faces a critical challenge to meet increasing demand for energy and imported energy or fuel is likely to become increasingly important in planning for infrastructure facilities.

Table 3: Total Energy Production and Consumption, by percentage, 2001

	Total Energy	
Region	Production	Consumption
Developing Asia	23	25
East Asia	11	13
Central and West	3	2
South Asia	5	6
Southeast Asia	4	4
World	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 122 countries.

Source: World Resources Institute, Energy and Resources Database 2008

In 2003, Asia's exports measured 13% of world fossil fuel exports while the region's imports were 20% of world fuel imports (Table 4). Both export and import shares of fossil fuels increased from their 1990 levels. By subregion, Southeast Asia exported almost half of Asia's fuel exports while East Asia's energy imports accounted for half of Asia's total energy imports. But the pattern differs by type of fossil fuel (Appendix Tables A.16–A.19).

Table 4: Total Fossil Fuel Trade, Thousand Tons of Oil Equivalent

Region	*Exports*		*Imports*	
	1990	*2003*	*1990*	*2003*
Developing Asia	9	13	11	20
East Asia	2	3	4	9
Central and West	0	3	0	1
South Asia	0	0	2	3
Southeast Asia	7	7	5	6
Other developing	59	59	12	15
OECD	31	28	77	66
Total	100	100	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 120 countries.

Source: World Resources Institute, Energy and Resources Database 2008.

For trade in oil and petroleum products, East Asia accounted for almost half of the region's total oil imports while Southeast Asia was the region's biggest oil exporter, contributing about 50% of the region's total oil exports in 2003 (Appendix Table A.20). Kazakhstan, with the greatest oil reserves in the region, alone constituted approximately 20% of Asia's total oil exports. Almost all of the region's natural gas exports occurred from Central, West, and Southeast Asia, with Turkmenistan and Indonesia contributing 33% and 32%, respectively. On the other hand, East Asia took up half of developing Asia's natural gas imports (Appendix Table A.21). East and Southeast Asia were the main source of coal exports, accounting for about 90% of Asia's coal exports in 2003. While a major coal exporter, East Asia also imports 65% of Asia's coal imports, of which Republic of Korea alone imports 50% (Appendix Table A.22).

The share in energy consumption of industry declined in the world over recent years while that in transportation remained more or less the same. The transportation sector in Asia uses less energy than the world average but, in absolute terms, the twofold growth of energy consumption in transportation in Asia was the highest in the world, compared to the world average of around 1.3–1.7 times during 1990–2003 (Appendix Table A.23).

Asian and Pacific countries need to invest in electricity generating capacity and transmission and distribution networks to sustain their current growth rates. The region has considerable commercial and renewable energy resources. This provides an opportunity for trans-boundary energy cooperation in utilizing these resources to achieve shared benefits for the countries involved. There are also further opportunities to increase generation of electric power using natural gas or hydropower in the region.

C. ICT Infrastructure

A total of 1.2 billion people in the region subscribed to telephone service in 2005, almost nine times that in 1996 (Appendix Table A.11). Despite this dramatic increase, the region still lags behind OECD levels. East Asia showed the highest telephone density among subregions whereas the Pacific had the lowest at 119 subscribers, about eight times lower than the East Asia's level (Appendix Table A.11). Except for East Asia, all subregions suffered lower telephone density than non-Asian developing counterparts. The pattern also holds when comparing telephone coverage by mobile and fixed line phones.

The number of internet users has increased dramatically all over the world, increasing 10 times during 1996–2005 (Appendix Table A.12). The average increase in Asia was a remarkable more than 200 times during the period whereas OECD countries experienced only a four times increase. However, some quality indicators such as internet users per 1,000 people, secure internet servers, and internet speed are still much lower in developing Asia than in OECD countries (Appendix Table A.13).

VII. SOFT INFRASTRUCTURE

In addition to the administrative aspects of trade facilitation, other forms of soft infrastructure influence international trade. These include (among others) availability of adequate credit and foreign exchange at reasonable rates, a reliable system of legal recourse, effective competition policy, and the capacity of existing human capital to process exchanges. Indeed, soft infrastructure may often be more important than physical infrastructure for increasing trade and its profitability.

Inefficient or burdensome institutional structures, bureaucracy, and policy may lead to reduced or foregone gains from international trade. During 2006–2007, most developing Asian countries were actively reforming their trade policies, with India being the top reformer. India introduced an online declaration system for imports and exports, reducing the time to trade (World Bank 2007). On average, producers in the region spend about one month to export whereas exporting takes only 10 days for their OECD counterparts. By subregion, Central and West Asia is still costlier than the rest of Asia although some countries such as Armenia are continuously reforming to make trading across borders easier (Table 5). The pattern is similar for importing, with time and cost to import being slightly higher than exporting in the region (Table A.14).

Table 5: Costs of Exporting, by Region, 2006–2007

Region	Documents for Import (number)	Time for Import (days)	Cost to Import (US$ per container)
Developing Asia and the Pacific			
East Asia	7	25	1,224
Central and West	11	58	2,511
The Pacific	8	28	1,112
South Asia	9	28	1,318
Southeast Asia	8	24	828
Other developing	8	33	1,522
OECD[1]	5	10	997
World[2]	8	30	1,430

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based available data from 179 countries.

Source: World Bank 2008

In the case of Indonesia, Patunru, Nurridzki, and Rivayani (forthcoming 2009) find that soft infrastructure plays a vital role in constraining port efficiency, more so than hard infrastructure, although the two are interlinked. Sea port competitiveness may suffer from poor physical infrastructure such as inadequate channel depth, shortage of berths, and limited cargo handling equipment, storage and transit areas, but it may also suffer from limitations in soft infrastructure, such as labor skills, regulation, bureaucracy, and other institutional factors affecting port capacity utilization. Lack of direct competition between ports controlled by the same government authority is also a critical factor.

Exploiting complementarity of hard and soft infrastructure raises overall trade and economic performance. This is especially noticeable in the case of networks. Many communication and infrastructure services that are important for economic development and trade expansion exhibit network externalities. Infrastructure networks exhibiting service externalities include telephones, railways, and water supply systems (for more information, see Laffont and Tirole 2000). In the presence of such externalities, the maximum amount that consumers are willing to pay for a good or service depends in part on the number of other consumers who also purchase the item in question. This interrelationship calls for consideration of these network systems' governance in competition policy.

Infrastructure improvements generally have the positive effect on competition of applying equally to both foreign and domestic entrants. This is particularly true when infrastructure improvements are complemented by effective competition policy that constrains monopoly power and removes barriers to entry (Brooks 2005). Hummels et al. (2007) demonstrate that ocean liners charge freight rates that are much higher for goods whose import demand is relatively inelastic, indicating that shipping firms were likely exercising market power.

VIII. INFRASTRUCTURE AND TRADE PATTERNS

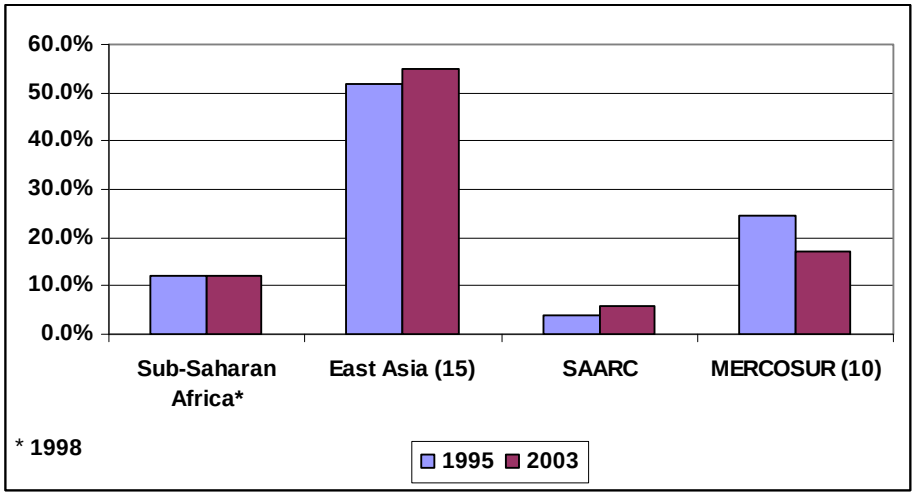
A notable feature of developing Asia's intraregional trade is the growing volume of shipments of parts and components across national borders. Fragmentation of production supply chains and sourcing raw and intermediate inputs from wherever costs (including incurred trade costs) are lowest has yielded benefits for both producers and consumers, as well as tax revenues for government budgets. To compete for larger shares in these benefits, countries have been striving to lower their costs by increasing the quantity and quality of

infrastructure services to support the production, distribution, and international trade of a widening array of intermediate goods and services.

Hummels (forthcoming 2009) looks at four types of recent changes in the composition of trade and their effects on demand for transportation: (1) changes in the ratio of weight to value of traded goods, (2) demand for timeliness and the shift towards increased air shipping, (3) new trade flows (both of products and geographical routes) and variation in the size of shipments, and (4) production fragmentation. The relationships are complex since the developments are interlinked. For example, declining weight/value ratios and vertical specialization in the fragmentation of new production supply chains generate new trade flows and patterns which spur the rapid growth in Asian air cargo shipments.

When infrastructure development lowers the marginal cost of trade, there can be increases in exports at both the extensive and intensive margins. The expansion at the extensive margin (of new products, to new destinations), typically through small shipments from small firms, influences the types of infrastructure demanded differently than does the deepening of existing trade flows. This is especially true for transportation infrastructure demand. ICT may also be of particular importance in establishing and consolidating new markets. When the new markets are inland, air transport may be a viable alternative to a combination of sea and land freight to avoid and reduce potential port congestion, noting that the shipping time savings are positively correlated with the shipping distances involved.

Figure 5: Intraregional Trade (% of total exports)



Sources: World Bank African Database 2005, Asian Development Bank 2006, International Monetary Fund, Direction of Trade Statistics 2006.

As infrastructure expanded in Asia, particularly in East Asia, trade costs fell and altered the comparative advantages of countries in the region, making greater fragmentation of production supply chains possible and spurring the region's intraregional trade in intermediate products. The subsequent economic integration in East Asia is sharply higher than in other developing regions (Figure 5). When inputs are being sourced from wherever costs are lowest and the production process increasingly dispersed geographically, then timeliness and reliability of delivery become critical factors and the influence of both physical and institutional infrastructure services is even more apparent. In support of its production fragmentation, East Asia's performance again stands out relative to other developing regions (Table 6).

Table 6: Border Trade Costs

Item	Sub-Saharan Africa	East Asia	South Asia	Latin America & Caribbean
Documents for export (number)	8.2	6.9	8.1	7.3
Time for export	40	23.9	34.4	22.2
Cost to export (US$ per container)	1,561	885	1,236	1,068
Documents for import (number)	12.2	9.3	12.5	9.5
Time for import (days)	51.5	25.9	41.5	27.9
Cost to import (US$ per container)	1,947	1,037	1,495	1,226

Source: World Bank 2008.

Infrastructure influences not only absolute, but comparative, advantage. Differences between countries in the quality of infrastructure services help to explain differences in total factor productivity. These impacts on productivity vary across sectors, depending on how intensively each sector uses infrastructure services and how reliant it is on good quality infrastructure services (and the availability of alternative production processes). Thus, patterns of specialization and trade are determined in part by the influence of infrastructure service quality on comparative advantage. Moreover, limitations in factor endowments may be mitigated by infrastructure services, also affecting the dynamics of comparative advantage. Under different conditions, infrastructure services may serve either as complements to, or substitutes for, physical inputs. The significance of factor endowments in determining comparative advantage may thus be modified by infrastructure development (Brooks and Leuterio 1997; Yeaple and Golub 2002).

The surge in oil prices during 2008 raised shipping (and therefore import) costs, shifting the balance in favor of domestic producers and inflation. Such changes as this can have a double or greater impact on products in international supply chains as both imported inputs and exported final products register higher prices. For example, PRC steel exported to the US and produced with iron ore imported from Brazil would be hit twice by higher fuel charges. The impact is greater where the goods (or their imported components) are shipped by air or have a high weight-to-value ratio and therefore where fuel accounts for a higher share of freight costs.

Malaysia is a prime example of a country where the government has actively promoted infrastructure development in order to strengthen its competitive and comparative advantage. Since the mid-1980s, Malaysia has pursued a FDI-led, export-oriented development strategy, with FDI contributing to the economy's integration in global production networks. As Tham, Devadason, and Heng (forthcoming 2009) point out, foreign firms have been attracted to Malaysia as a key link in global supply chains by the country's competitive locational advantages, which in turn are closely linked to its infrastructure development and resulting high quality services. Institutional infrastructure at the macroeconomic level, in the form of exchange rate policy, has also played an important role.

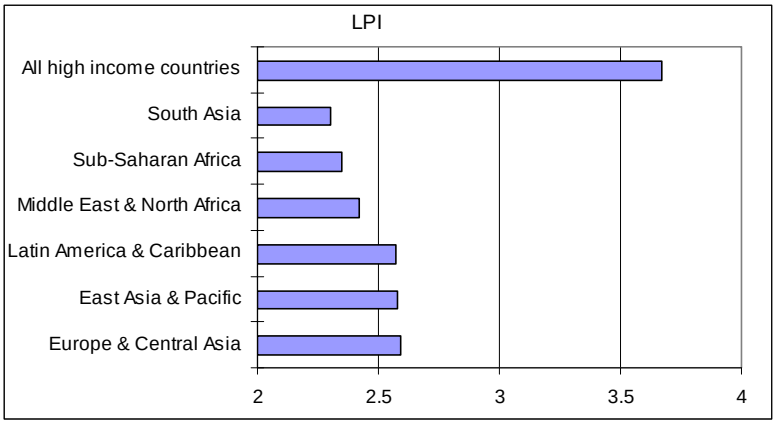
Tham et al. elucidate the role of infrastructure in attracting export-oriented FDI by observing FDI's sectoral and locational pattern and through interviews with local managers of foreign firms' subsidiaries involved in international trade. The location of FDI is shown to be biased toward areas with relatively good infrastructure and amenities. Thus, infrastructure improvements increase the chances of attracting FDI, which in Asia has frequently been directed toward export sectors, in turn, influencing patterns and quantities of imported raw materials and intermediate inputs.

Amiti and Javorcik (2006) find that market and supplier access are the most important factors affecting foreign entry, and have about four times as great an effect as production costs on choice of foreign investment location. In particular they find that in PRC, access to markets and suppliers within the province of entry matters more than access to the rest of the country, consistent with observed market fragmentation. An increase of one standard deviation in the number of sea berths is found to increase foreign entry by about 11%, while a one standard deviation increase in the length of rail lines increases it by 7%. This reinforces the observation that provinces with more developed ports, and to a lesser extent a more developed rail network, tend to attract greater FDI flows. Over time, however, congestion, security concerns, connectivity of airports, and delays in processing trade documentation may reduce the positive impact of infrastructure on lowering trade costs for foreign investors.

IX. LOGISTICS

Successful production and trade networks demand superior logistics services and centers such as Singapore; Taipei,China; Hong Kong, China; Republic of Korea; Malaysia; Thailand; and PRC have built well developed logistics systems to facilitate international and intraregional trade. However, these logistics systems are still evolving and will come under increasing strains as concentrations of economic activities expand inland. While East Asia's international logistics performs relatively well compared to other developing regions, South Asia's does not. And even East Asia's performance is still well behind that of high income countries (Figure 6).

Figure 6: International Logistics Performance Index



Note: International LPI mainly reflects infrastructure, customs, international shipments, logistics competence, tracking & tracing, domestic logistics costs, timeliness, etc.

Source: World Bank 2007a.

Reducing process time and its variability in fragmented production processes depends on integrated logistics infrastructure. This can be crucial in sectors such as fashion clothing or auto parts where the use of just-in-time production and delivery processes are widespread. Several country specific studies suggest that inland locations would impose a large logistic burden: for example, almost 63% of the cost of transporting goods from Chongqing in the PRC to the west coast of the US is incurred before the goods arrive at the PRC port for export (Carruthers and Bajpai 2002). The deficiencies of Central Asian transport systems—high costs coupled with low quality transport and logistics services—have meant that close to 20% of the value of traded goods is accounted for by transport costs. A 20% reduction in logistics costs would increase the trade to GDP ratio by more than 10% in Cambodia, Lao

PDR, and PRC; over 15% in Mongolia; and by more than 20% in Papua New Guinea (Carruthers and Bajpai 2002).

The challenges of providing efficient logistical support rise as countries move into progressively more complex and higher-value manufacturing, and as production processes become increasingly fragmented. As new countries and regions join these supply chains and Asian production networks expand over a larger and more diffuse space, logistics requirements become more sophisticated and demanding, increasing pressure on underlying infrastructure, both hard and soft. Already there is a premium on timeliness and reliability of delivery, care and security in handling and transporting, and certification and standardization of product quality. Both the quantity and quality of logistics services in trade create competitiveness and value added. Freight-forwarding, warehousing, storage, packaging, shipping services, and ICT infrastructure services are becoming increasingly important.

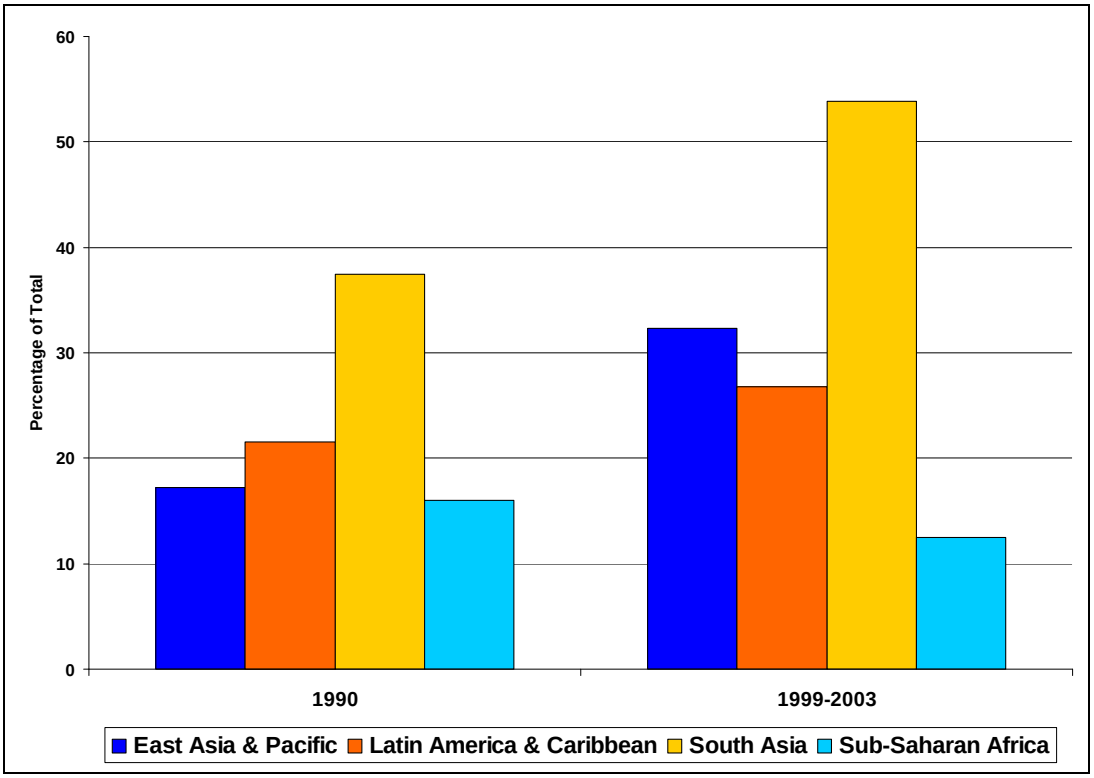
As supply chains have fragmented both domestically and internationally, managing and coordinating the various steps in a production process must now be complemented by managing and coordinating the service links between those steps, often at great distance. Minimizing monetary and time costs while ensuring reliability of delivery service depends on the services of efficient logistics systems.

The linkage between the quality of logistics and type of commodity being transported involves three factors (Arnold forthcoming 2009). First is the value of the commodity per shipment unit, e.g., per metric ton or twenty-foot equivalent units (TEU). Second is the shelf life of the commodity, reflecting physical deterioration or volatility of demand. The third factor is the scheduling requirements of the importers, such as just-in-time manufacturers, or retailers with coordinated national sales programs.

X. PORT AND MODAL CHOICE

Asian infrastructure has expanded quickly to support the region's rapid trade growth and economic integration relative to other developing regions (Figure 7 and Table 7). However, the growth has not always been smooth and symmetric. Just as the financial balance of trade flows is frequently uneven, so is the physical balance of the volumes shipped. Unbalanced international trade volume creates additional costs for managing shipping capacity, utilization of infrastructure adjacent to port areas, and cargo clearance, as well as possible macroeconomic imbalances. With berth space in ports now a constraining factor in Asia's trade expansion, exploiting complementarities with other modes of transportation infrastructure becomes an urgent priority. At the same time, changes in production and trade patterns are affecting modal usage. For example, greater shipments of goods with higher value per unit weight and sharply higher reward for timeliness of delivery are reducing the relative importance of sea transportation vis-à-vis air, although sea shipments still dominate overall.

Figure 7: Paved Roads



Source: World Bank 2007b.

Table 7: Intraregional Comparisons

		Africa	East Asia	South Asia	LAC
Merchandise Trade (% of GDP)	*2005*	57.8	74.6	31.2	44.2
Gross Fixed Capital Formation (% of GDP)	*2004*	18.4	33.8	22.9	19.5
Gross Domestic Savings (% of GDP)	*2004*	17.9	37.9	20.1	23.8
Cumulative inward FDI flows (billions US$)	*1990–2005*	125.0	1340.0	65.0	725.0
Intra-regional Trade Shares* (%)	*2003*	12.2	55.0	6.0	15.0
Infrastructure					
Electricity Consumption (kWh per capita)	*2003*	513.0	1184.3	393.9	1614.5
Fixed Line and Mobile Subscribers (per 1,000)	*2004*	90.6	431.7	75.3	496.0
Internet Users (per 1,000)	*2005*	29.0	88.6	49.0	156.1
Electric Power Transmission and Distribution Losses (% of output)	*2003*	12.0	7.3	26.4	16.1
Paved Roads (% of total)	*1999–2003*	12.5	32.3	53.9	26.8

Source: World Bank 2007b.

Air cargo involving Asian nations has grown much faster than at the global level, with especially rapid growth involving intra-Asian international flights. The rapid growth in Asian air cargo is driven by declining weight/value ratios of products shipped and steep declines in the price of air cargo. For air shipping, average revenue per ton-kilometer shipped dropped by a factor of 10 between 1955 and 2004, largely due to technological advances (Hummels 2007). In addition, four factors seem especially important: rising incomes, vertical specialization/fragmentation of production, entry into new markets (often on a trial basis), and trade between geographically remote locations.

Higher income consumers in higher income countries demand higher quality imports. Rising incomes affect demand for air transport in three ways. First, higher quality goods have higher prices and therefore transportation cost is a lower ad-valorem share of the delivered price. Second, as consumers grow richer, so does their willingness to pay for particular product characteristics. That offers incentive for producers to manufacture to specification, and to adjust production and shipments quickly and flexibly. Third, delivery speed is itself an important aspect of product quality for many consumers, and demand for timely delivery will rise as income grows (Hummels forthcoming 2009).

Cargo owners' port choice is influenced by distance and time to ports, shipping routes and intended destination(s), and total costs. Indirect trade-offs in regulatory compliance and enforcement, and between port location and security of delivery (and quality of delivered product), also influence choices of ports and modes of transportation.

Producers generally choose a port that is consistent with minimum distribution cost including time effectiveness, regulatory requirements, and unscheduled costs, as well as monetary costs. Patunru et al. (forthcoming 2009) explore exporters' assessments of sea port competitiveness in the context of the Indonesian archipelago, where roughly 90% of external trade (and much of domestic trade) passes through sea ports. Competition may be in the form of inter-port, intra-port, or intra-terminal competition. Comparing Tanjung Perak Port in Surabaya and Tanjung Emas Port in Semarang, their analysis considers captive and contestable hinterlands and port-choice decision making by exporters in the contestable hinterlands. They find that exporters concerned with raw materials distribution are more likely to exhibit the "trade follows the ships" principle, where exporters are attracted to use ports with shipping routes that best reach the desired markets. Regions more dominated by service sector exports generally exhibit the "ships follow the trade" principle, in which ships are routed to serve those regions.

While port performance is crucial to the Indonesian archipelago, capitalizing on the links and complementarities between different modes of transportation can boost trade substantially. Air and sea ports can move more goods, particularly in containerized shipping, when served by efficient rail and road networks, ICT infrastructure, and storage yards. Improvements in infrastructure service efficiency can lead to cost savings equivalent to moving production to locations thousands of kilometers closer to trading partners.

Ma and Zhang (forthcoming 2009) find that in recent years PRC exporters have experienced fluctuating trends in freight and insurance costs for ocean trade but a steady decrease in those for air cargo. In 2002, the ad valorem costs of air freight and insurance fell below those of sea freight and insurance, and have remained lower since. Over the period from 1990 to 2004, the share of air cargo was relatively constant in terms of weight but about tripled in terms of value. Their analysis finds that relative to the country's average trade with the rest of the world, PRC's exports are lower and declining in terms of the weight-to-value ratio while imports are higher and increasing (reflecting the rise in imports of raw materials). Like Malaysia, PRC is expanding port infrastructure partly as a means to attract FDI from potential exporters and thereby increase both trade and competitiveness.

XI. TRADE-RELATED INFRASTRUCTURE AND REGIONAL COOPERATION

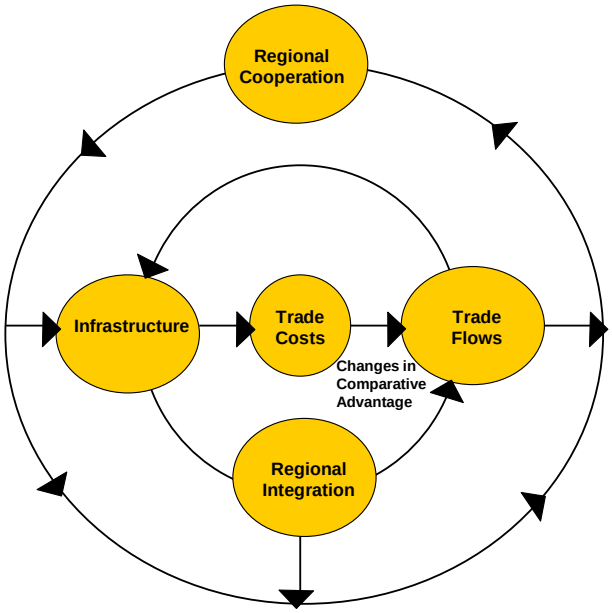
Infrastructure services can yield positive externalities. For example, developing a new road infrastructure project to relieve congestion in port access produces advantages not only for the users of the project but also for users of other roads where congestion is lessened as a result of the new project. Even non-users gain through reduction of pollution and improvement of the natural environment, and the country as a whole benefits through reduction of oil consumption or oil imports as well as increased trade benefits.

Efforts to take advantage of economies of scale in production, procurement, or marketing, lead firms to look beyond national borders for both trade and investment opportunities. Promoting efficient financial intermediation, coordinating and promoting regional public goods, reducing macroeconomic vulnerability to shocks, and strengthening security ties offer governments similar incentives to design, develop, and manage regional infrastructure cooperation and integration. In this context, infrastructure is one of the "three I's," along with incentives and institutions, that are key determinants of overall growth and the magnitude and productivity of capital inflows as economies liberalize (Hill 2004).

As production services become increasingly fragmented and traded internationally, cooperation among the economies participating in those production networks becomes more crucial to maintain or raise an individual host country industry's competitiveness in supplying those services. Regional infrastructure coordination can lower infrastructure costs and limit environmental and other negative social impacts, while still contributing to trade expansion. In the case of the GMS, special forums have been established to coordinate transport, telecommunications, and electric power infrastructure developments, particularly for the development of cross-country economic corridors (Asian Development Bank [ADB] 2006).

Infrastructure not only fosters economic growth, but also strengthens inclusiveness and reduces poverty. Especially, infrastructure investment that reduces trade costs facilitates regional economic integration through trade and investment expansion, which motivates regional cooperation, including cooperation in infrastructure development, generating a virtuous cycle. A simple depiction of the relationships is presented in Figure 8.[6]

Figure 8: Changes in Comparative Advantages



[6] I am grateful to Peter Rimmer for helpful suggestions in refining this diagram.

The diversity of Asian economies, combined with infrastructure expansion and enhancement to lower trade costs, has helped the region to capitalize on global patterns of production fragmentation, expanding intraregional trade, and diversification of development opportunities. The impacts of trade-related infrastructure are now being leveraged by coordination across borders in a wide variety of institutional architectures and trade agreements. In this evolving international context, the role of harmonizing and strengthening soft infrastructure stands out as an essential partner for enhanced physical infrastructure. Supported by a conducive policy environment and internalizing regional spillover effects through cooperative arrangements, the expansion, improvement, and maintenance of infrastructure services is reducing trade costs and facilitating trade expansion, regional integration, and economic growth and development.

Weiss (2008) presents a framework for considering the role of infrastructure in regional cooperation. He utilizes a modified formulation of the effective rate of protection to flexibly quantify the empirical significance of trade cost barriers that are broader than the familiar tariffs and quotas. Infrastructure investments and interventions, both hard and soft, are then seen to be instruments to reduce trade costs and thereby stimulate closer intraregional trading linkages. In this manner, the height of barriers posed by different types of trade costs suggests a rough ranking of priorities for infrastructure development to reduce these barriers, which vary across countries.

Factors like high freight costs, delays in customs clearance, unofficial payments, slow port landing and handling, and poor governance create barriers to trade. Institutional bottlenecks (administrative, legal, financial, regulatory, and other logistics infrastructure), information asymmetries, and discretionary powers that give rise to rent seeking activities by government officials at various steps of trade transactions also impose costs. These costs can be lowered through cooperation that facilitates trade logistics for merchandise and services in both inbound and outbound shipments.

At the international level, cooperation through preferential trade and investment agreements that strengthen structural reforms and increase the attractiveness of a location for foreign investment can leverage domestic policy actions and their impacts on growth, equity and efficiency, and may help to reduce corruption. Cross-border cooperation in building and maintaining soft infrastructure can therefore lead synergistically to a reduction in trade costs and stimulate further investment in physical infrastructure, trade, production and employment, and growth.

XII. CONCLUSIONS

Over the next few decades, developing Asian economies are expected to make up most of the fastest growing markets in the world. An important part of this growth will come through trade expansion, regional integration through the fragmentation of production networks across national borders, and the broadening and deepening of international capital flows to support this trade and production expansion.

Major advances have been made in Asia in the provision of trade-related infrastructure. However, further infrastructure development is required to sustain current economic growth and regional integration. A joint ADB–Japan Bank for International Cooperation (JBIC)–World Bank (2005) study estimated that a huge amount—more than US$200 billion per year—is needed to fund estimated needs in infrastructure. New or improved roads, power plants, communications facilities, and water and sanitation systems are urgently needed in developing countries across the region. The PRC alone is expected to require about 80% of the total investment. Relative to their size, many smaller and poorer developing countries in the region also face severe bottlenecks that call for large investments in infrastructure.

International trade is growing in value and shrinking in weight per unit value. Exports are expanding most notably at the extensive margin, diversifying across new markets with

smaller flows, and fragmented production networks are becoming the norm. Each of these trends puts emphasis on speed, flexibility, and information. Cross-border infrastructure that facilitates the expansion of trade along these lines will boost a country's export competitiveness and its efficient integration into the global economy (Hummels forthcoming 2009).

The demand for information and related services such as finance and telecommunications can be expected to grow faster than the demand for transportation of goods and people. Similarly, as the density of economic activity increases with population and income growth, and modern flexible manufacturing practices spread and move production closer to consumers, there is likely to be an increasing demand for short-haul relative to long-haul transportation and facilitating infrastructure investments in both the domestic and international contexts.

Efforts to expand and enhance infrastructure services will reduce costs of doing business in Asia, of achieving economies of scale, and of international trade, helping to maximize growth and the benefits of regional trade and investment integration. At the same time, infrastructure improvements, complemented by trade expansion, will attract and facilitate greater investment in productive capacity, expand access to markets and employment opportunities for the poor, and broaden the range of consumer choice for Asia's billions.

APPENDIX

Table A.1: Road Transport, by Region, 1996 and 2004

Road Transport

Region	Paved Roads % of Total Roads		Total Roads Network Thousand Kilometers	
	1996	2004	1996	2004
Developing Asia and the Pacific	49.1	65.3	5,407.9	7,385.1
East Asia	58.7	83.9	1,319.1	2,022.1
Central and West Asia	75.0	68.6	579.0	598.4
The Pacific	23.7	..	27.9	..
South Asia	41.1	46.0	2,673.7	3,745.3
Southeast Asia	47.2	62.5	808.2	1,019.4
Other developing	40.6	46.4	7,531.9	..
OECD[1]	81.4	79.9	11,300.0	14,000.0
World[2]	47.6	55.5	24,300.0	..

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based on available data from 179 countries

Source: World Bank 2007b.

Table A.2: Road Transport, by Country and Sub-region, 1996 and 2004

	Paved Roads % of Total Roads		Total Roads Network Kilometers	
	1996	2004	1996	2004
East Asia				
PRC	..	81.0	1,185,789	1,870,661
Hong Kong, China	100.0	100.0	1,760	1,943
Republic of Korea	72.7	86.8	82,342	100,279
Mongolia	3.3	..	49,250	..
Central and West Asia				
Afghanistan	13.3	23.7	21,000	34,782
Armenia	96.7	..	16,286	..
Azerbaijan	93.9	49.4	26,818	59,141
Georgia	93.5	39.4	20,298	20,247
Kazakhstan	80.5	93.4	141,076	90,018
Kyrgyz Republic	91.1	..	18,500	..
Pakistan	44.0	64.7	224,931	258,340
Tajikistan	..	..	28,536	..
Uzbekistan	87.3	..	81,600	..
The Pacific				
Fiji	49.2	..	3,440	..
Kiribati	..	..	670	..
Micronesia, Fed. Sts.	17.7	..	240	..
Papua New Guinea	3.5	..	19,600	..
Samoa	42.0	..	790	..
Solomon Islands	2.5	..	1,360	..
Tonga	27.0	..	680	
Vanuatu	23.9	..	1,070	..
South Asia				
Bangladesh	8.4	..	196,413	..
Bhutan	60.7	..	3,285	..
India	54.7	..	2,367,062	..
Nepal	41.5	30.3	7,700	17,380
Sri Lanka	40.0	..	99,200	..
Southeast Asia				
Cambodia	7.5	6.3	35,769	38,257
Indonesia	46.3	..	336,377	..
Malaysia	74.4	81.3	63,383	98,721
Myanmar	12.2	..	28,200	..
Philippines	17.4	..	161,264	..
Singapore	97.3	100.0	2,988	3,188
Thailand	97.5	..	64,600	..
Viet Nam	25.1	..	93,300	222,179

Source: World Bank 2007b

Table A.3: Railway Transport, by Region, 1996 and 2005

Region	Rail lines, Total Route km		Goods Transported million ton-km		Passengers Carried million passenger-km	
	1996	2005	1996	2005	1996	2005
Developing Asia and the Pacific	170,965.8	181,713.0	1,730,980.9	2,593,743.0	784,091.0	1,259,855.0
East Asia	60,910.0	67,402.0	1,307,730.0	1,953,577.0	367,347.0	594,556.0
Central and West Asia	28,496.0	33,768.0	133,430.0	218,801.0	21,593.0	40,061.0
The Pacific	..	597.0	..	..	..	..
South Asia	66,922.1	66,379.0	278,457.4	408,432.0	363,869.6	584,724.0
Southeast Asia	14,637.7	13,567.0	11,363.5	12,933.0	31,281.4	40,514.0
Other developing	237,473.5	373,127.0	1,593,484.0	2,627,406.0	395,613.4	352,108.0
OECD[1]	396,453.5	472,102.0	3,196,582.0	3,389,390.0	322,348.1	492,256.1
World[2]	804,892.8	1,026,942.0	6,521,047.0	8,610,539.0	1,502,053.0	2,104,219.0

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based on available data from 179 countries.

Source: World Bank 2007b.

Table A. 4: Freight and Passengers Carried by Air Transport, 1996 and 2005

Region	Freight, million ton/km		Passengers Carried, million	
	1996	2005	1996	2005
Developing Asia and the Pacific	17,838.1	37,859.7	183.3	337.6
East Asia	8,242.8	22,781.9	85.4	191.0
Central and West Asia	513.3	535.3	11.1	12.5
The Pacific	101.3	117.9	2.0	2.2
South Asia	884.0	1,274.3	16.8	32.6
Southeast Asia	8,096.7	13,150.3	68.0	99.3
Other developing	8,991.8	16,615.4	178.0	273.0
OECD[1]	61,050.1	86,483.4	1,020.0	1,400.0
World[2]	87,880.0	140,958.6	1,381.3	2,010.6

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included

2 The world aggregates were estimated based on available data from 179 countries

Source: World Bank 2007b.

Table A. 5: Goods and Passengers Carried by Railway, by Country, 1996 and 2005

	Railway			
	Net ton/kms, millions		Passenger/kms, million	
	1996	2005	1996	2005
East Asia				
PRC	1,310,616.0	2,072,602.0	334,759.0	606,196.0
Hong Kong, China	30.0	7.0	3,914.0	4,731.0
Republic of Korea	12,947.0	..	29,580.0	31,004.0
Mongolia	2,529.0	9,947.7	733.0	1,234.3
Central and West Asia				
Armenia	351.0	654.0	84.0	27.0
Azerbaijan	2,778.0	9,628.0	558.0	878.0
Georgia	1,141.0	..	380.0	..
Kazakhstan	112,688.0	171,855.0	14,188.0	12,136.0
Kyrgyz Republic	481.0	662.0	92.0	46.0
Pakistan	4,538.0	5,011.0	19,114.0	23,609.0
Tajikistan	1,719.0	1,066.0	95.0	46.0
Uzbekistan	20.0	..	2.0	..
South Asia				
Bangladesh	689.0	..	3,333.0	..
India	277,567.0	439,596.0	357,013.0	615,634.0
Sri Lanka	107.0	..	3,103.0	..
Southeast Asia				
Cambodia	4.0	..	22.0	..
Indonesia	4,700.0	..	15,223.0	..
Malaysia	1,398.0	..	1,385.0	..
Myanmar	748.0	..	4,294.0	..
Philippines	0.0	..	69.0	..
Singapore	..	..		..
Thailand	3,286.0	..	12,205.0	..
Viet Nam	1,684.0	..	2,261.0	..

Source: UN Statistics Division, Common Database 2008

Table A.6: Freight and Passengers Carried by Air, by Country, 1996 and 2005

	Freight, Million Ton/km		Passengers Carried	
	1996	2005	1996	2005
East Asia				
PRC	1,688.60	7,579.40	51,770,100	136,700,000
Hong Kong, China	..	7,763.87	..	20,229,512
Republic of Korea	6,550.90	7,432.57	33,002,700	33,888,328
Mongolia	3.30	6.07	661,500	295,252
Central and West Asia				
Afghanistan	13.50	..	255,600	..
Armenia	11.80	7.04	358,100	555,795
Azerbaijan	27.60	11.92	1,232,900	1,134,300
Georgia	1.80	2.75	152,400	249,131
Kazakhstan	16.70	15.83	568,000	1,160,286
Kyrgyz Republic	1.60	2.03	488,200	225,923
Pakistan	427.20	407.93	5,375,000	5,364,134
Tajikistan	2.80	6.14	594,000	479,172
Turkmenistan	2.10	10.09	523,000	1,653,638
Uzbekistan	8.20	71.58	1,566,200	1,639,276
The Pacific				
Fiji	75.40	92.11	479,600	870,571
Kiribati	0.90	..	28,400	..
Marshall Islands	2.60	0.33	41,300	25,789
Papua New Guinea	18.00	21.11	970,000	818,773
Samoa	1.50	1.81	270,000	266,625
Solomon Islands	1.70	0.80	94,300	91,450
Tonga	..	..	56,000	..
Vanuatu	1.20	1.78	72,800	112,254
South Asia				
Bangladesh	135.70	183.49	1,252,000	1,634,473
Bhutan	..	0.25	35,000	49,092
India	565.00	773.22	13,394,600	27,527,738
Maldives	6.80	0.01	206,900	81,945
Nepal	17.90	6.94	755,000	480,266
Sri Lanka	158.60	310.36	1,170,700	2,817,778
Southeast Asia				
Cambodia	..	1.20	..	168,810
Indonesia	749.40	439.77	17,138,800	26,835,524
Lao PDR	0.90	2.48	124,500	293,442
Malaysia	1,414.60	2,577.58	15,117,600	20,369,086
Myanmar	1.20	2.72	334,500	1,503,624
Philippines	384.50	322.71	7,263,100	8,056,829
Singapore	4,115.00	7,571.26	11,840,700	17,744,017
Thailand	1,348.20	2,002.42	14,078,300	18,902,629
Viet Nam	82.90	230.19	2,107,500	5,453,683

Source: World Bank 2007b.

Table A.7: Vessels Cleared and Entered, by Country, 1996 and 2005

	Sea			
	Vessels cleared, 1000 tons		Vessels entered, 1000 tons	
	1996	2005	1996	2005
East Asia				
PRC	..	..	..	..
Hong Kong, China	229,474.0	424,477.0	229,444.0	424,703.0
Republic of Korea	542,600.0	..	537,163.0	..
Mongolia	..	..	..	..
Central and West Asia				
Armenia	..	..	..	..
Azerbaijan	..	1,578.4	..	1,626.8
Georgia	..	..	..	..
Kazakhstan	..	..	..	..
Kyrgyz Republic	..	..	..	..
Pakistan	7,728.0	23,917.0	22,632.0	41,189.0
Tajikistan	..	..	..	..
Uzbekistan	..	..	..	..
South Asia				
Bangladesh	3,136.0	..	5,928.0	..
India	44,494.0	..	48,358.0	..
Sri Lanka	..	..	29,882.0	..
Southeast Asia				
Cambodia	145.0	..	726.0	..
Indonesia	75,055.0	84,769.1	259,096.0	273,721.6
Malaysia	146,827.0	..	154,191.0	..
Myanmar	1,962.0	..	2,806.0	..
Philippines	..	..	..	..
Singapore	117,662.0	..	117,723.0	..
Thailand	22,231.0	..	93,033.0	..
Viet Nam	..	..	..	..

Source: UN Statistics Division, Common Database 2008.

Table A.8: Electricity Production and Consumption

Region	Electric Power Consumption Billion kWh		Electric Power Consumption kWh per capita		Electricity Production Billion kWh	
	1996	2004	1996	2004	1996	2004
Developing Asia						
East Asia	1,230.0	2,450.0	3,344.2	4,488.0	1,310.0	2,600.0
Central and West Asia	191.0	227.0	1,672.0	1,854.0	233.0	282.0
South Asia	361.0	522.0	175.0	252.5	454.0	700.0
Southeast Asia	256.0	431.0	1,552.9	2,125.8	287.0	475.0
Other developing	2,730.0	3,390.0	1,959.0	2,386.0	3,120.0	3,900.0
OECD[1]	7,520.0	8,620.0	9,273.6	10,737.1	7,980.0	9,080.0
World[2]	12,288.0	15,640.0	3,248.0	3,858.7	13,384.0	17,037.0

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based available data from 179 countries.

Source: World Bank 2007b.

Table A. 9: Electric Power Consumption, by Country, 1996 and 2004

	Total Consumption Billion kWh		Per Capita Consumption, kWh	
	1996	2004	1996	2004
East Asia				
PRC	999.4	2,055.0	820.9	1,585.1
Hong Kong, China	31.7	39.2	4,930.9	5,699.3
Republic of Korea	194.9	355.4	4,280.7	7,390.9
Central and West Asia				
Armenia	3.9	4.3	1,237.2	1,428.2
Azerbaijan	14.5	20.3	1,868.1	2,437.4
Georgia	5.6	7.1	1,133.9	1,577.3
Kazakhstan	54.7	54.4	3,514.0	3,621.2
Kyrgyz Republic	7.0	7.2	1,508.9	1,421.2
Pakistan	45.3	64.6	361.0	425.0
Tajikistan	13.0	14.4	2,217.4	2,239.7
Turkmenistan	6.2	8.3	1,444.7	1,740.5
Uzbekistan	41.0	46.4	1,763.2	1,795.7
South Asia				
Bangladesh	9.6	19.4	81.0	139.6
India	346.9	493.8	365.6	457.3
Nepal	1.1	1.8	48.4	68.8
Sri Lanka	3.8	6.7	204.8	344.2
Southeast Asia				
Indonesia	59.5	104.1	304.5	478.2
Malaysia	46.2	78.8	2,209.0	3,165.5
Myanmar	2.6	5.2	56.7	103.6
Philippines	30.6	48.7	437.6	597.1
Singapore	23.2	34.6	6,313.9	8,169.9
Thailand	80.5	118.8	1,364.7	1,864.6
Viet Nam	13.7	41.2	184.1	501.4

Source: World Bank 2007b.

Table A.10: Electric Power Production and Transmission Losses

	Electricity Production billion kWh		Transmission and Distribution Losses % of output		Transmission and Distribution Losses million kWh	
	1996	2004	1996	2004	1996	2004
East Asia						
PRC	1,080.0	2,200.0	7.1	6.3	76,950.0	139,000.0
Hong Kong, China	28.4	37.1	14.3	12.5	4,054.0	4,657.0
Republic of Korea	202.6	366.6	5.2	3.5	10,500.0	12,790.0
Central and West Asia						
Armenia	6.2	6.0	37.8	15.9	2,349.0	956.0
Azerbaijan	17.1	21.6	15.9	12.8	2,721.0	2,762.0
Georgia	7.2	6.9	29.1	15.6	2,095.0	1,079.0
Kazakhstan	59.0	66.9	15.2	15.5	8,976.0	10,410.0
Kyrgyz Republic	13.8	15.1	33.2	30.2	4,565.0	4,575.0
Pakistan	59.1	85.7	23.4	24.6	13,850.0	21,070.0
Tajikistan	15.0	17.3	11.7	14.8	1,761.0	2,561.0
Turkmenistan	10.1	11.5	11.2	13.3	1,131.0	1,521.0
Uzbekistan	45.4	51.0	8.9	8.8	4,061.0	4,500.0
South Asia						
Bangladesh	11.5	21.5	16.0	9.5	1,834.0	2,038.0
India	436.7	667.8	20.9	26.3	91,110.0	175,500.0
Nepal	1.2	2.3	20.9	19.5	255.0	457.0
Sri Lanka	4.5	8.0	17.1	16.7	774.0	1,346.0
Southeast Asia						
Cambodia	..	0.8	..	..	..	..
Indonesia	66.7	120.2	10.8	13.4	7,197.0	16,110.0
Malaysia	51.4	82.9	10.1	4.9	5,174.0	4,095.0
Myanmar	3.9	6.4	35.1	19.5	1,383.0	1,256.0
Philippines	36.7	56.0	16.7	12.9	6,128.0	7,227.0
Singapore	24.1	36.8	3.9	5.9	928.0	2,167.0
Thailand	87.4	125.7	8.7	7.9	7,575.0	9,981.0
Viet Nam	16.9	46.0	19.3	10.5	3,264.0	4,829.0

Source: World Bank 2007b

Table A.11: Mobile and Mainline Phone Subscribers, by Region, 1996 and 2005

Region	Telephone Subscribers by 1,000 People		Telephone Subscribers per 1,000 People		Mobile Phone Subscribers, Thousand		Mobile Phone Subscribers per 1,000 People		Telephone Mainlines by 1,000 People		Telephone Mainlines per 1,000 People	
	1996	2005	1996	2005	1996	2005	1996	2005	1996	2005	1996	2005
Developing Asia and the Pacific												
East Asia	89,500.0	819,000.0	333.9	983.4	11,400.0	441,000.0	71.9	641.4	78,100.0	378,000.0	262.1	342.0
Central and West Asia	8,679.5	23,700.0	78.8	190.2	107.0	24,500.0	0.4	146.9	8,572.5	13,000.0	78.4	94.9
The Pacific	165.4	382.0	50.9	119.5	7.1	294.2	1.9	82.3	158.2	208.4	49.0	63.2
South Asia	15,700.0	155,000.0	18.4	189.0	403.0	103,000.0	0.7	141.9	15,200.0	52,600.0	17.7	47.1
Southeast Asia	22,300.0	190,000.0	110.1	458.2	5,420.6	144,000.0	26.9	349.4	16,900.0	45,800.0	83.2	113.4
Other developing	158,000.0	924,000.0	107.3	495.5	10,600.0	692,000.0	8.3	358.2	150,000.0	268,000.0	99.0	138.5
OECD[1]	569,000.0	1,200,000.0	665.0	1,466.6	114,000.0	732,000.0	136.5	960.1	455,000.0	482,000.0	528.5	528.7
World[2]	863,344.9	3,312,082.0	177.5	591.0	141,937.8	2,136,794.2	26.3	410.5	723,930.7	1,239,608.4	151.2	185.3

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based available data from 179 countries

Source: World Bank 2007b.

Table A.12: Internet Usage, by Region, 1996 and 2005

	Internet Users, Thousand		Internet Users per 1,000 People		Broadband Subscribers by 1,000 People		Broadband Subscribers per 1,000 People	
	1996	2005	1996	2005	1996	2005	1996	2005
Developing Asia and the Pacific								
East Asia	1,191.4	148,000.0	15.7	345.4	..	51,400.0	..	130.2
Central and West Asia	15.5	11,600.0	0.3	51.4	..	49.5	..	0.3
The Pacific	2.2	239.2	1.2	43.3	..	0.5	..	0.9
South Asia	461.6	60,500.0	0.8	25.2	..	1,316.2	..	2.1
Southeast Asia	765.1	44,900.0	15.6	125.3	..	1,366.4	..	35.0
Other developing	3,647.4	200,000.0	3.4	126.9	..	16,800.0	..	15.4
OECD[1]	66,900.0	301,000.0	66.1	535.2	..	139,000.0	..	162.7
World[2]	72,983.2	766,239.2	14.7	179.0	..	209,932.5	..	49.5

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based available data from 179 countries

Source: World Bank 2007b

Table A.13: Quality of Internet, by Region, 1996 and 2005

	International Internet Bandwidth (bits per person)		International Internet Bandwidth, mbps		Secure Internet Servers		Secure Internet Servers per 1 Million People	
	1996	2005	1996	2005	1996	2005	1996	2005
Developing Asia and the Pacific								
East Asia	0.0	2,650.5	0.3	62,884.5	..	2,504.0	..	45.7
Central and West Asia	0.0	14.6	0.6	108.7	..	92.0	..	1.0
The Pacific	0.2	30.1	0.0	6.0	..	44.0	..	24.3
South Asia	0.1	44.4	3.1	4,121.9	..	710.0	..	1.8
Southeast Asia	1.4	38.6	7.2	2,633.7	..	2,193.0	..	32.7
Other developing	0.1	347.0	2.8	2,712.4	..	11,693.0	..	43.6
OECD[1]	4.0	8,514.6	59.2	82,672.5	..	380,352.0	..	347.2
World[2]	0.8	1,662.8	10.5	22,162.8	..	397,588.0	..	70.9

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based available data from 179 countries

Source: World Bank 2007b.

Table A.14: Costs of Importing, by Region, 2006–2007

Region	Documents for Import (number)	Time for Import (days)	Cost to Import (US$ per container)
Developing Asia and the Pacific			
East Asia	7	25	1,224
Central and West	11	58	2,511
The Pacific	8	28	1,112
South Asia	9	28	1,318
Southeast Asia	8	24	828
Other developing	8	33	1,522
OECD[1]	5	10	997
World[2]	8	30	1,430

Note: 1 Czech Republic, Hungary, Mexico, Poland, Slovak Republic, Turkey, and Republic of Korea are not included in OECD average as they are grouped into developing countries. Other 23 OECD economies are included.

2 The world aggregates were estimated based available data from 179 countries.

Source: World Bank 2008

Table A.15: Proved Energy Reserves, Million Tons of Oil Equivalent, 2006

	Oil	Gas	Coal
East Asia	**2,219**	**2,204**	**58,927**
PRC	2,219	2,204	58,900
Hong Kong, China	..	..	..
Republic of Korea	..	..	27
Mongolia	..	..	..
Central and West Asia	**6,543**	**8,890**	**20,827**
Afghanistan	..	..	..
Armenia	..	..	..
Azerbaijan	955	1,215	
Georgia	..	..	..
Kazakhstan	5,433	2,700	19,810
Kyrgyz Republic	..	..	..
Pakistan	..	718	1,017
Tajikistan	..	..	..
Turkmenistan	75	2,574	
Uzbekistan	81	1,683	
South Asia	**777**	**1,359**	**60,843**
Bangladesh	..	392	..
Bhutan	..	..	..
India	777	968	60,843
Maldives	..	..	..
Nepal	..	..	..
Sri Lanka	..	..	..
Southeast Asia	**1,665**	**5,716**	**2,454**
Cambodia	..	..	..
Indonesia	587	2,369	1,903
Lao PDR	..	..	..
Malaysia	573	2,232	..
Myanmar	..	484	..
Philippines	..	..	..
Singapore	..	..	..
Thailand	62	271	451
Viet Nam	443	360	100

Source: World Resources Institute, Energy and Resources Database 2008,

Table A.16: Trade in Oil and Petroleum Products, by Region, Thousand Tons of Oil Equivalent

Region	Exports		Imports	
	1990	2003	1990	2003
Developing Asia	9	10	12	22
East Asia	2	2	4	10
Central and West	0	2	0	1
South Asia	0	1	2	4
Southeast Asia	7	5	6	7
Other developing	67	67	12	13
OECD	24	23	76	66
World	100	100	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 120 countries.

Source: World Resources Institute, Energy and Resources Database 2008

Table A.17: Trade in Natural Gas, by Region, Thousand Tons of Oil Equivalent

Region	Exports		Imports	
	1990	2003	1990	2003
Developing Asia	20	17	1	8
East Asia	0	0	1	4
Central and West	0	8	0	2
Southeast Asia	20	9	0	2
Other developing	24	45	17	26
OECD	56	37	81	66
World	100	100	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 120 countries

Source: World Resources Institute, Energy and Resources Database 2008.

Table A.18: Trade in Coal and Coal Products, by Region, Thousand Tons of Oil Equivalent

Region	Exports		Imports	
	1990	2003	1990	2003
Developing Asia	6	30	12	21
East Asia	5	15	9	13
Central and West	0	2	0	1
South Asia	0	0	2	4
Southeast Asia	1	12	1	3
Other developing	27	30	14	17
OECD	67	40	74	63
World	100	100	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 120 countries.

Source: World Resources Institute, Energy and Resources Database 2008

Table A.19: Total Fossil Fuel Trade, Thousand Tons of Oil Equivalent

Region	Exports		Imports	
	1990	2003	1990	2003
Developing Asia	9	13	11	20
East Asia	2	3	4	9
Central and West	0	3	0	1
South Asia	0	0	2	3
Southeast Asia	7	7	5	6
Other developing	59	59	12	15
OECD	31	28	77	66
Total	100	100	100	100

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 120 countries.

Source: World Resources Institute, Energy and Resources Database 2008.

Table A.20: Trade in Oil and Petroleum Products, by Country, Thousand Tons of Oil Equivalent

	Exports		Imports	
	1990	2003	1990	2003
East Asia	**36,327**	**53,456**	**70,435**	**281,570**
PRC	30,644	23,462	6,491	129,623
Hong Kong, China	1,953	1,428	8,533	14,687
Republic of Korea	3,730	28,566	55,411	137,260
Mongolia	..	..	..	..
Central and West Asia	**346**	**65,958**	**8,944**	**20,049**
Afghanistan	..	..	..	..
Armenia	..	0	..	350
Azerbaijan	..	10,999	..	12
Georgia	..	110	..	594
Kazakhstan	..	47,125	..	3,763
Kyrgyz Republic	..	146	..	518
Pakistan	346	1,058	8,944	13,446
Tajikistan	..	15	..	1,272
Turkmenistan	..	6,081	..	90
Uzbekistan	..	424	..	4
South Asia	**3,129**	**15,014**	**34,346**	**108,869**
Bangladesh	135	49	2,010	4,031
Bhutan	..	..	..	..
India	2,779	14,965	30,157	100,312
Maldives	..	..	..	..
Nepal	0	0	261	794
Sri Lanka	215	0	1,918	3,732
Southeast Asia	**117,734**	**139,382**	**112,878**	**200,187**
Cambodia	..	.. ..	..	..
Indonesia	49,055	35,095	9,227	33,376
Lao PDR	..	.. ..	..	..
Malaysia	27,651	29,050	8,403	15,570
Myanmar	22	0	0	940
Philippines	707	1,506	12,476	17,522
Singapore	36,846	48,391	61,347	83,200
Thailand	770	7,880	18,478	38,859
Viet Nam	2,683	17,460	2,947	10,720

Source: World Resources Institute, Energy and Resources Database 2008,

Table A.21: Trade in Natural Gas, by Country, Thousand Tons of Oil Equivalent

	Exports		Imports	
	1990	2003	1990	2003
East Asia	**0**	**1,237**	**2,680**	**23,969**
PRC	0	1,237	0	0
Hong Kong, China	0	0	0	1,237
Republic of Korea	0	0	2,680	22,732
Mongolia	..	..	..	..
Central and West Asia	**0**	**47,606**	**0**	**13,348**
Afghanistan	..	..	..	..
Armenia		0		973
Azerbaijan		0		3,305
Georgia		0		756
Kazakhstan		9,230		7,291
Kyrgyz Republic		0		590
Pakistan	0	0	0	0
Tajikistan		0		433
Turkmenistan		35,338		0
Uzbekistan		3,038		0
Southeast Asia	**31,956**	**57,041**	**0**	**10,794**
Cambodia	..	..	..	..
Indonesia	24,146	33,468	0	0
Lao PDR	..	..	..	..
Malaysia	7,810	18,313	0	0
Myanmar	0	5,260	0	0
Philippines	0	0	0	0
Singapore	0	0	0	4,483
Thailand	0	0	0	6,311
Viet Nam	0	0	0	0

Source: World Resources Institute, Energy and Resources Database 2008,

Table A.22: Trade in Coal and Coal Products, by Country, Thousand Tons of Oil Equivalent

	Exports		Imports	
	1990	2003	1990	2003
East Asia	**12,077**	**70,383**	**22,253**	**57,895**
PRC	12,077	70,383	1,036	5,911
Hong Kong, China	0	0	5,492	6,566
Republic of Korea	0	0	15,725	45,418
Mongolia	..	..	..	..
Central and West Asia	**0**	**10,983**	**592**	**3,136**
Afghanistan	..	..	..	..
Armenia		0		12
Azerbaijan		0		0
Georgia		1		25
Kazakhstan		10,961		733
Kyrgyz Republic		14		479
Pakistan	0	0	592	1,835
Tajikistan		0		46
Turkmenistan		0		0
Uzbekistan		7		6
South Asia	**46**	**868**	**4,498**	**15,568**
Bangladesh	0	0	281	350
Bhutan	..	..	..	..
India	46	868	4,163	14,982
Maldives				
Nepal	0	0	49	168
Sri Lanka	0	0	5	68
Southeast Asia	**3,466**	**56,080**	**2,652**	**12,131**
Cambodia	..	..	..	..
Indonesia	2,989	52,079	492	0
Lao PDR	..	..	..	..
Malaysia	21	27	1,090	4,031
Myanmar	0	446	31	0
Philippines	0	0	789	3,902
Singapore	14	0	35	8
Thailand	0	0	205	4,190
Viet Nam	442	3,528	10	0

Source: World Resources Institute, Energy and Resources Database 2008,

Table A.23: Energy Consumption in Transportation, Million Liters

	Diesel Oil		Motor Gasoline	
	1990	2003	1990	2003
Developing Asia	1,134	1,895	725	2,143
East Asia	427	719	161	302
Central and West	34	155	10	966
South Asia	69	110	21	37
Southeast Asia	604	912	534	838
Other developing	6,357	9,383	9,302	12,866
OECD	7,471	12,673	13,543	13,667
World	14,962	23,951	23,570	28,676

Note: Regional aggregates are calculated based on data for counties who reported. The world total is based on data for 122 countries

Source: World Resources Institute, Energy and Resources Database 2008

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